

**DEPARTMENT OF THE ARMY**  
**OFFICE OF THE QUARTERMASTER GENERAL**

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**THE APPLIED ENVIRONMENTAL RESEARCH PROGRAM**  
**OF THE**  
**DEPARTMENT OF THE ARMY**

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**ANNUAL REPORT**

**JUNE 1961**



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**QM RESEARCH & ENGINEERING COMMAND**  
**NATICK, MASS.**

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## FOREWORD

THIS REPORT, PREPARED BY THE U.S. ARMY QUARTERMASTER CORPS, IS THE SEVENTH IN A SERIES OF ANNUAL REPORTS, PRESENTING INFORMATION ON THE STATUS OF APPLIED ENVIRONMENTAL RESEARCH WITHIN THE DEPARTMENT OF THE ARMY. ACCOMPLISHMENTS ACHIEVED DURING THE PERIOD 10 JUNE 1960 TO 10 JUNE 1961 ARE SUMMARIZED IN FULFILLMENT OF RESPONSIBILITY FOR PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT IN THE FIELD OF APPLIED ENVIRONMENTAL RESEARCH, ASSIGNED TO THE QUARTERMASTER GENERAL BY DEPARTMENT OF THE ARMY MEMORANDUM, 10 JUNE 1949, FILE CSGLD/F1 28507, SUBJECT: ASSIGNMENT OF RESEARCH AND DEVELOPMENT COGNIZANCE IN THE FIELDS OF CRYOLOGICAL PHENOMENA, METEOROLOGY, AND ENVIRONMENTAL RESEARCH (APPENDIX 1), AND EXTENDED BY D/F, 30 JUNE 1952, FILE G4/F2 41949, SUBJECT: TRANSFER OF SIX ARMY-WIDE ENVIRONMENTAL RESEARCH PROJECTS TO THE QUARTERMASTER GENERAL (APPENDIX 2). THIS REPORT ON APPLIED ENVIRONMENTAL RESEARCH, AS DEFINED IN THE MEMORANDUM REFERENCED ABOVE, IS PREPARED IN COMPLIANCE WITH R&D DIRECTIVE No. 21, O/CR&D, 24 MAY 1960 (APPENDIX 3).

THE ASSISTANCE OF THE CHEMICAL CORPS, CORPS OF ENGINEERS, ORDNANCE CORPS, MEDICAL CORPS, SIGNAL CORPS, AND TRANSPORTATION CORPS IS GRATEFULLY ACKNOWLEDGED.

# THE APPLIED ENVIRONMENTAL RESEARCH PROGRAM OF THE DEPARTMENT OF THE ARMY

## 1. INTRODUCTION

THIS REPORT IS THE ANNUAL ACCOUNTING BY THE QUARTERMASTER CORPS OF ITS STEWARDSHIP OF APPLIED ENVIRONMENTAL RESEARCH WITHIN THE DEPARTMENT OF THE ARMY. THIS STEWARDSHIP IS EXERCISED BY THE QUARTERMASTER CORPS UNDER ITS PRIMARY COGNIZANCE FOR THE FIELD AS DEFINED AND ASSIGNED BY THE GENERAL STAFF, U.S. ARMY (APPENDIX 1).

APPLIED ENVIRONMENTAL RESEARCH IS A FORM OF MILITARY GEOGRAPHY—THE STUDY OF THE ENVIRONMENT POINTED TOWARD THE SOLUTION OF LOGISTICAL PROBLEMS. A SEARCHING EXAMINATION OF THE ENVIRONMENT IS NECESSARY FOR ADEQUATE DESIGNING, REALISTIC TESTING, DEVELOPMENT OF SOUND FIELD DOCTRINE, AND SUCCESSFUL ACTION OF MEN IN THE FIELD. THE ENVIRONMENT MUST BE TAKEN INTO CONSIDERATION BY SCIENTISTS AND ENGINEERS IN LAUNCHING THE MOST MODERN ROCKET IN FLORIDA OR CALIFORNIA, AS WELL AS BY SMALL GROUPS OF SOLDIERS CONDUCTING GUERRILLA WARFARE IN DIM TROPICAL FORESTS. SUCCESS OF THE LAUNCHING OR OF THE GUERRILLA ACTION DEPENDS IN PART UPON THE DEGREE TO WHICH ENVIRONMENTAL FACTORS HAVE BEEN CONSIDERED IN PRIOR DEVELOPMENT OF MATERIEL AND DOCTRINE.

THE ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM OF THE ARMY IS CARRIED OUT BY ALL TECHNICAL SERVICES AND USCONARC, INDIVIDUALLY AND THROUGH COOPERATIVE EFFORT. COORDINATION IS ACHIEVED THROUGH MEETINGS OF THE ARMY COMMITTEE ON ENVIRONMENT ON WHICH ALL TECHNICAL SERVICES ARE REPRESENTED; THE ARMY SCIENTIFIC ADVISORY PANEL; AND THE ARMY RESEARCH OFFICE, OFFICE OF THE CHIEF OF STAFF. IN ADDITION, THERE IS FREQUENT EXCHANGE OF IDEAS THROUGH CONFERENCES AND CORRESPONDENCE AT ALL LEVELS.

TWO MAJOR ASPECTS OF ARMY ENVIRONMENTAL RESEARCH AND DEVELOPMENT CAN BE DISTINGUISHED: THE FIRST IS DEVOTED TO DISCOVERING THE NATURE OF THE ENVIRONMENT; THE SECOND IS DEVOTED TO DEVELOPING MATERIEL THAT WILL FUNCTION PROPERLY UNDER ALL ENVIRONMENTAL STRESSES IN PROTECTING SOLDIERS AND HELPING THEM ACHIEVE SUCCESS IN BATTLE. OBVIOUSLY THESE TWO ASPECTS OF STUDY ARE MUTUALLY DEPENDENT. THERE IS NOT ALWAYS A SHARP LINE OF DEMARCATION BETWEEN THEM, THOUGH MOST OF THE RESEARCH IN THE FIRST CATEGORY IS DONE BY EARTH SCIENTISTS (GEOGRAPHERS, CLIMATOLOGISTS, METEOROLOGISTS, SOIL SCIENTISTS, ECOLOGISTS, ETC.), WHILE THAT OF THE SECOND IS MORE LIKELY TO BE DONE BY ENGINEERS. ALL THE TECHNICAL SERVICES ARE COMMITTED TO DEVELOPMENT AND TESTING OF MATERIEL AND ITS USE BY SOLDIERS UNDER ALL ENVIRONMENTS; RESEARCH ON THE ENVIRONMENT PER SE, ON THE OTHER HAND, IS CARRIED OUT BY THE QUARTERMASTER CORPS UNDER ITS PRIMARY COGNIZANCE, THOUGH MAJOR CONTRIBUTIONS IN CERTAIN ASPECTS ARE MADE BY OTHER TECHNICAL SERVICES.

IN CARRYING OUT THEIR RESEARCH RESPONSIBILITIES, ARMY SCIENTISTS DRAW UPON ALL AVAILABLE SOURCES OF INFORMATION AND MUST BE AWARE OF NEW AND IMPORTANT DEVELOPMENTS IN THEIR FIELDS IN THIS COUNTRY AND THROUGHOUT

THE WORLD. PROFESSIONAL JOURNALS ARE A MAJOR SOURCE OF INFORMATION; IN ADDITION, CONTACTS ARE MAINTAINED WITH OTHER SCIENTISTS THROUGH ATTENDANCE AT SCIENTIFIC MEETINGS, EXCHANGE AGREEMENTS, CORRESPONDENCE, AND VISITS TO SCIENTIFIC INSTITUTIONS. FOR EXAMPLE, DURING THE PAST YEAR THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT STOCKHOLM WAS ATTENDED BY A NUMBER OF EARTH SCIENTISTS FROM THE DEPARTMENT OF THE ARMY. FIVE ARMY GEOGRAPHERS AND CLIMATOLOGISTS PRESENTED PAPERS AT THE CONGRESS AND ONE WAS RE-ELECTED TO SERVE AS CHAIRMAN OF ONE OF THE WORLDWIDE SCIENTIFIC COMMISSIONS DURING THE NEXT FOUR YEARS. BY MAINTAINING THEIR STATUS AS AN ACTIVE PART OF THE SCIENTIFIC COMMUNITY, ARMY SCIENTISTS ARE ABLE TO BUILD AND MAINTAIN A STAFF OF COMPETENT PERSONNEL, SECURE THE COOPERATION OF OUTSTANDING AUTHORITIES FOR CONTRACT WORK, KEEP THEIR OWN RESEARCH UP-TO-DATE WITH RECENT DEVELOPMENTS, AND AVOID WASTEFUL DUPLICATION OF WORK THAT HAS ALREADY BEEN DONE ELSEWHERE.

THE MAIN BODY OF THIS REPORT GIVES AN ACCOUNT OF THE PRINCIPAL RESEARCH EFFORTS OF THE PAST YEAR. ACCOMPLISHMENTS DURING THIS TIME GIVE PROMISE OF VALUABLE ADDITIONS IN SUBSEQUENT YEARS. COMPREHENSIVE CLIMATIC ATLASES, RECENTLY PUBLISHED, OF TEMPERATURE FREQUENCIES IN THE COLDER PORTIONS OF THE NORTHERN HEMISPHERE WILL BE FOLLOWED BY OTHERS OF TROPICAL AND DESERT REGIONS; NEW TECHNIQUES OF TERRAIN ANALYSIS WILL BE GIVEN FURTHER APPLICATIONS; ON-THE-SPOT INVESTIGATIONS OF DIFFICULT ENVIRONMENTS WILL BE EXTENDED TO OTHER TYPES OF AREAS; AND FROM MANY OTHER ANGLES, SOME NOT YET CONCEIVED, THE UNLIMITED PROBLEMS OF THE ENVIRONMENT WILL BE ANALYZED, BROUGHT TO FOCUS UPON ARMY PROBLEMS, DIGESTED INTO USABLE DOCUMENTS AND MANUALS, AND INCORPORATED INTO THE DESIGN AND USE OF ARMY MATERIEL.

## 2. CHEMICAL CORPS

THE CHEMICAL CORPS CONTINUED ITS PROGRAM OF ENVIRONMENTAL TESTING AT SITES LOCATED IN EACH OF THE FIVE MAJOR WORLD CLIMATES. THESE SITES ARE ADMINISTERED FROM THE U.S. ARMY CHEMICAL CORPS PROVING GROUND, DUGWAY PROVING GROUND, DUGWAY, UTAH. THEY ARE LOCATED AT FORT GREELY, ALASKA — ARCTIC; YUMA TEST STATION, ARIZONA — DESERT; CAMP CENTURY, GREENLAND — POLAR; FORT CLAYTON, CANAL ZONE — TROPIC; AND ARMY CHEMICAL CENTER, MARYLAND — TEMPERATE.

IN OCTOBER 1960, OFFICIAL TRANSFER OF THE POLAR TEAM WAS MADE FROM CAMP TUTO ON THE EDGE OF THE ICECAP TO CAMP CENTURY, 138 MILES TOWARD THE INTERIOR OF GREENLAND. HERE THE U.S. ARMY CHEMICAL CORPS POLAR ENVIRONMENTAL TEST AND RESEARCH TEAM SHARES WITH OTHER MILITARY RESEARCH AGENCIES A FACILITY COMPLETELY BELOW THE ICECAP SURFACE AND HOUSED IN TUNNELS WITHIN THE SNOW. FIGURE 1, WHICH SHOWS A LABORATORY AND ITEMS IN STORAGE, ILLUSTRATES THIS UNIQUE INSTALLATION.

AS ESTABLISHED BY ARMY REGULATIONS, THE ENVIRONMENTAL TESTING PROGRAM PROVIDES ASSURANCE THAT CHEMICAL CORPS MATERIEL HAS AN ALL-WEATHER CAPABILITY. THE PROGRAM DETERMINES THE ABILITY OF THE ITEMS TO WITHSTAND STORAGE AND TO FUNCTION ADEQUATELY IN WORLDWIDE ENVIRONMENTS. THERE ARE CURRENTLY 30 ITEMS IN THE TEST PROGRAM.

CHEMICAL CORPS PERSONNEL TOOK PART IN OPERATION LEAD DOG 60 WHICH WAS ADMINISTERED BY THE U.S. ARMY TRANSPORTATION CORPS. THE OBJECTIVE OF CHEMICAL CORPS PARTICIPATION WAS TO TEST VARIOUS CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL ASPECTS OF THE APPROACH MARCH IN THE POLAR ENVIRONMENT. AMONG THE PROBLEM AREAS STUDIED WAS THE EFFECTIVENESS OF EXISTING CBR

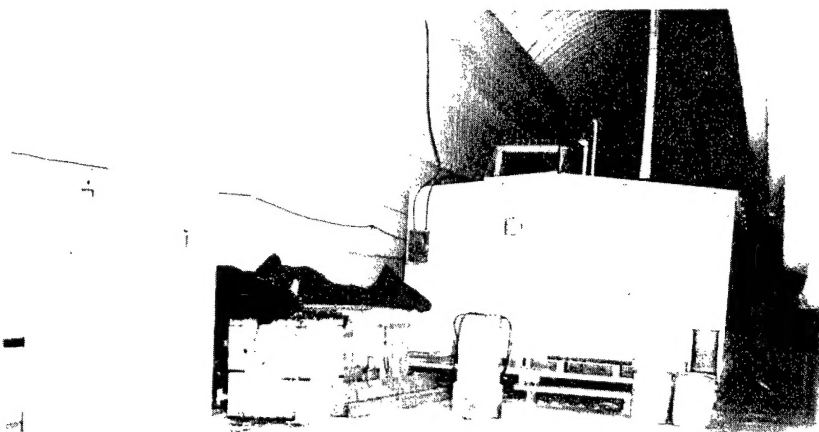


FIGURE 1: CHEMICAL CORPS INSTALLATION IN ICE TUNNEL AT CAMP CENTURY



DEFENSIVE EQUIPMENT. THE EFFECT OF LONG-CONTINUED WEARING OF PROTECTIVE MASKS UPON PERSONNEL WAS EVALUATED; THE UTILITY OF SIGNALING SMOKES DURING PERIODS OF "OVERCAST WHITEOUT" WAS STUDIED; AND THE EFFICIENCY OF COLLECTIVE PROTECTOR FILTER UNITS WAS DETERMINED.

SPECIAL TESTS OF A NEW AUTOMATIC FIELD ALARM WERE MADE AT THE ARCTIC AND DESERT TEST SITES IN COLLABORATION WITH CHEMICAL RESEARCH AND DEVELOPMENTAL LABORATORIES. DATA OBTAINED RESULTED IN REDESIGN OF DEFICIENT FEATURES OF THE ALARM.

CONTINUED EMPHASIS WAS PLACED ON STUDIES OF BEHAVIOR OF TOXIC AGENTS UNDER ARCTIC CONDITIONS. THE SPECIAL PROBLEM OF CONTAMINATED SNOW "PICKUP" ON CLOTHING WAS EXPLORED. IT WAS FOUND THAT CERTAIN TYPES OF SHOE COVERING WERE SUPERIOR TO OTHERS.

SPECIAL TESTS WERE CONDUCTED AT THE TROPIC SITE TO EVALUATE HUMID-HEAT CONDITIONS ON PROTECTIVE MASKS AND THE CANISTERS USED WITH THEM. BECAUSE THE ADSORBENT MATERIAL IN THE CANISTER ADSORBS MOISTURE AS WELL AS ADSORBING AND NEUTRALIZING TOXIC AGENTS, TROPIC TESTS ARE SPECIALLY SIGNIFICANT.

STANDARD TESTS HAVE LED TO MANY MODIFICATIONS OF MATERIEL. SINCE THESE TESTS ARE CONDUCTED AT ALL ENVIRONMENTAL SITES, RESULTS ARE APPLICABLE IN ALL ENVIRONMENTS. AN EXAMPLE OF AN ACTIONABLE RESULT OF TESTING PERTAINS TO THE M3A3 SMOKE GENERATOR. IT WAS FOUND AT ONE SITE, AND CONFIRMED AT OTHERS, THAT THE PRESSURIZING VALVE WAS DEFECTIVE AND THE VALVE HAS BEEN REDESIGNED.

### 3. CORPS OF ENGINEERS

#### A. ARMY MOBILITY RESEARCH CENTER

THE U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, OPERATING UNDER PROJECT 8S70-05-001, TRAFFICABILITY AND MOBILITY RESEARCH, IS CONDUCTING STUDIES OF OFF-ROAD MOVEMENT OF MILITARY VEHICLES UNDER THE TWO GENERAL SUBJECTS, TRAFFICABILITY AND VEHICLE MOBILITY RESEARCH.

TRAFFICABILITY STUDIES ARE DIRECTED TOWARD THE DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES FOR DIRECT OR REMOTE MEASUREMENT OF THE ABILITY OF THE VARIOUS MATERIALS OF THE EARTH'S SURFACE TO SUPPORT THE MOVEMENT OF MILITARY VEHICLES UNDER ALL ENVIRONMENTAL CONDITIONS. TRAFFICABILITY RESEARCH WAS EXPANDED DURING THE YEAR TO INCLUDE THE INVESTIGATION OF ELECTROMAGNETIC MEANS OF ESTIMATING TRAFFICABILITY FROM THE AIR. A NEW FACILITY WAS BUILT FOR THIS PURPOSE AND A TEST PROGRAM UTILIZING THE INFRARED PORTION OF THE ELECTROMAGNETIC SPECTRUM WAS INITIATED.

MOBILITY RESEARCH IS AIMED AT DEVELOPING FUNDAMENTAL KNOWLEDGE OF THE RELATIONS BETWEEN THE DYNAMIC LOADING OF SOIL AND SNOW BY GROUND VEHICLES AND THE BEHAVIOR OF THESE MATERIALS UNDER SUCH LOADING. THIS KNOWLEDGE WILL PROVIDE BASES FOR THE RATIONAL DESIGN OF COMBAT VEHICLES WITH MAXIMUM CROSS-COUNTRY CAPABILITY IN SPECIFIED ENVIRONMENTS WHILE FULFILLING STIPULATED REQUIREMENTS IN ARMOR AND FIREPOWER.

MOBILITY RESEARCH DURING THE PAST YEAR DEALT PRIMARILY WITH THE MOTION OF A PNEUMATIC TIRE THROUGH SAND AND THE DISTRIBUTION OF PRESSURES UNDER PNEUMATIC TIRES AT THE SURFACE OF CONTACT WITH SOILS.

#### B. MILITARY EVALUATION OF GEOGRAPHIC AREAS

R AND D TASK 8S71-05-001-06, MILITARY EVALUATION OF GEOGRAPHIC AREAS, WHICH IS CONDUCTED AT THE U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, HAS AS ITS PRINCIPAL OBJECTIVES A STUDY OF CORRELATIONS BETWEEN ENVIRONMENTAL CHARACTERISTICS AND MILITARY PERFORMANCE, AND THE DEVELOPMENT OF SYSTEMS FOR DESCRIBING AND COMPARING AREAS IN RESPECT TO THOSE ENVIRONMENTAL PROPERTIES AFFECTING MILITARY ACTIVITIES. THE MAJOR OBJECTIVE THEN IS TO DEVELOP METHODS OF CLASSIFYING AND COMPARING GEOGRAPHIC AREAS IN TERMS OF THE EFFECT OF THE NATURAL AND MAN-MODIFIED ENVIRONMENT UPON MILITARY ACTIVITIES. TO ACCOMPLISH THESE OBJECTIVES, WORK THUS FAR HAS BEEN DIRECTED INTO THREE PRINCIPAL LINES OF APPROACH:

(1) A SURVEY OF VARIOUS SOURCES OF INFORMATION TO DETERMINE THE STRESSES IMPOSED BY ENVIRONMENT BOTH IN WAR-TIME OPERATIONS AND IN PEACE-TIME MANEUVERS AND TESTS. SOURCES INCLUDE WAR-TIME OPERATIONAL RECORDS, TEST REPORTS, MANEUVER REPORTS, AND LIAISON.

(2) DEVELOPMENT OF QUALITATIVE OBJECTIVE CLASSIFICATION SYSTEMS FOR VARIOUS ENVIRONMENTAL FACTORS SUCH AS SOILS, SURFACE GEOMETRY, VEGETATION, HYDROGRAPHY, AND CLIMATIC CHARACTERISTICS, SO THAT AREAS CAN BE

MAPPED IN CONSISTENT AND MEANINGFUL WAYS. THESE SYSTEMS WILL PROVIDE RATIONAL BASES FOR APPLYING OPERATIONAL EXPERIENCES IN ONE AREA TO OTHER LIKE AREAS.

(3) ANALYSIS AND COMPARISON WITH OTHER AREAS OF THE WORLD OF THE ENVIRONMENTS OF TESTING SITES AT YUMA, FORT CHURCHILL AND FORT GREELY, AND THE CANAL ZONE, TO DETERMINE HOW REPRESENTATIVE THEY ARE OF DESERT, ARCTIC OR SUBARCTIC, AND TROPICAL AREAS, RESPECTIVELY.

THE DETERMINATION OF MILITARILY SIGNIFICANT ENVIRONMENTAL FACTORS HAS INCLUDED AN EXTENSIVE STUDY OF WORLD WAR II AND KOREAN WAR OPERATIONAL RECORDS OF TROOP UNITS, AND, TO A LESSER EXTENT, A STUDY OF MANEUVER REPORTS, USER TEST REPORTS, AND OTHER MILITARY RECORDS. THE DEVELOPMENT OF UNIVERSAL CLASSIFICATION SYSTEMS FOR DESCRIBING AND COMPARING AREAS IS BEING ACCOMPLISHED THROUGH STUDIES OF THE TESTING SITES NAMED ABOVE. FIELD STUDIES OF THE TERRAIN CHARACTERISTICS OF THESE TESTING SITES HAVE BEEN MADE AND REPORTS PREPARED THEREON. CLIMATIC STUDIES OF THESE SITES HAD ALREADY BEEN MADE BY THE QUARTERMASTER CORPS WHICH IS COOPERATING WITH THE CORPS OF ENGINEERS IN CONDUCTING CLIMATIC ANALOG STUDIES COMPARING THESE TEST SITES WITH OTHER WORLD AREAS. TERRAIN ANALOG STUDIES ARE BEING MADE BY VARIOUS CE ORGANIZATIONS AND BY UNIVERSITIES UNDER CONTRACT. MAJOR PROGRESS IN THE DEVELOPMENT OF SUITABLE TERRAIN CLASSIFICATION SYSTEMS HAS BEEN MADE IN RESPECT TO VEGETATION AND TERRAIN GEOMETRY. STUDIES TO DEVELOP SUITABLE CLASSIFICATION SYSTEMS FOR HYDROLOGIC CHARACTERISTICS AND SURFACE ROUGHNESS ARE IN PROGRESS.

A STUDY IS PRESENTLY UNDER WAY TO SELECT AND MAKE GROUND MEASUREMENTS ON DESERT TERRAIN TESTING COURSES FOR THE OVERLAND TRAIN AT YUMA, UNDER A COOPERATIVE PROGRAM WITH THE TRANSPORTATION CORPS. THIS STUDY WILL UTILIZE AND TEST THE TERRAIN CLASSIFICATION AND MAPPING TECHNIQUES DEVELOPED UNDER THE OVER-ALL PROJECT. IT IS EXPECTED THAT THE DETAILED OBSERVATIONS BEING MADE ON THESE TEST COURSES WILL BE OF GREAT VALUE IN ANALYZING CAUSE-EFFECT RELATIONSHIPS DURING THE TESTS ON THIS EXPERIMENTAL VEHICLE.

### C. CLIMATIC AND ATMOSPHERIC PHYSICS

THE U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, OPERATING UNDER PROJECT 8S66-02-001, COLD REGIONS RESEARCH, HAS A CONTRACT WITH THE UNIVERSITY OF MICHIGAN TO STUDY VISIBILITY IN SNOW-DOMINATED REGIONS. THE CONTRACTOR CONDUCTED FIELDWORK AT KEWEENAW FIELD STATION (KFS) FOR ABOUT 6 WEEKS, MEASURING AND RECORDING LIGHT FLUCTUATIONS, AIR TEMPERATURE, AND WINDSPEED PROFILES.

THE STUDY OF ATMOSPHERIC SHIMMER BY THE UNIVERSITY OF MICHIGAN CONTINUED ALONG TWO LINES: (1) ANALYZING DATA FROM THE 1959-60 SEASON AT KFS AND (2) INSTALLING AND TESTING EQUIPMENT TO BE USED DURING THE 1960-61 SEASON AT THE MICROMETEOROLOGICAL FIELD STATION AT WILLOW RUN AIRPORT, MICHIGAN. CORRELATION BETWEEN SCINTILLATION PERCENT MODULATION, TEMPERATURE DIFFERENCE, WINDSPEED, AND WIND DIRECTION RELATIVE TO THE OPTICAL PATH WAS INVESTIGATED. THE DEPENDENCE OF SCINTILLATION INCREASED. STABILITY WAS STUDIED.

SNOW BLOWING AND DRIFT-CONTROL HAVE BEEN ACTIVELY STUDIED DURING THE REPORT PERIOD WITH EXPERIMENTAL SNOW FENCES AT KFS, THEORETICAL STUDIES AT WILMETTE, AND BY WIND TUNNEL TESTS (UNDER CONTRACT) AT NEW YORK UNIVERSITY. LAST WINTER'S FIELD WORK ON SNOW FENCES AT KFS SHOWED THE VALUE OF LIGHT-WEIGHT PORTABLE FENCES CAPABLE OF FAR MORE PRECISE CONTROL OF ACCUMULATION THAN CAN BE ACHIEVED BY PERMANENTLY INSTALLED FENCES. PROBLEMS OF ADEQUATE STRENGTH AND STABILITY WITH EXTREME PORTABILITY WERE SATISFACTORILY SOLVED FOR CONDITIONS AT HOUGHTON.

PROMISING RESULTS ARE COMING FROM THE WIND-TUNNEL TESTS ON DRIFTING SNOW, USING 1:100 MODELS OF THE DYE BUILDINGS AND OF STRUCTURES TO BE BUILT BY THE NAVY AT BYRD STATION (FIGS. 2, 3, 4). CLOSE CORRELATION BETWEEN MODEL AND PROTOTYPE SNOWDRIFT PATTERN WAS OBSERVED, BASED ON A SURVEY OF A DYE SITE MADE AFTER THE WINTER SEASON. MODEL TESTS WERE OBSERVED BY REPRESENTATIVES OF THE CORPS OF ENGINEERS, AIR FORCE, NAVY, AND ARCHITECT-ENGINEERS (METCALF AND EDDY, AND LA PIERRE, LITCHFIELD ASSOCIATES), AND TIME-LAPSE MOVING PICTURES AS WELL AS MANY STILL PHOTOGRAPHS WERE TAKEN. THE STATISTICAL ANALYSIS OF SALTATION PHENOMENA WAS COMPLETED.

WHITEOUT-DISPERSING TECHNIQUES AND MATERIALS WERE TESTED AT SITE II AND NEAR THULE AFB, GREENLAND, DURING THIS PERIOD (56). SUCCESSFUL CLEARING OF AREAS OF SUPERCOOLED LOW CLOUDS WAS MADE ON SEVERAL OCCASIONS AT SITE II USING SOLID  $\text{CO}_2$ , BUT THE WARM-TYPE FOGS OF THE THULE AREA DEFIED MODIFICATION AT THIS TIME. THE CONTRACTOR, CORNELL UNIVERSITY (AERONAUTICAL LABORATORY), EXPERIMENTED ALSO WITH HYGROSCOPIC SALT AND WITH CARBON BLACK PARTICLES, BUT THE SOLID  $\text{CO}_2$  WAS BY FAR THE BEST NUCLEATING AGENT (FIG. 5).

### D. RELATED PROGRAMS

THE U.S. ARMY ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES, OPERATING UNDER PROJECT 8S66-02-001, REGIONAL PLANNING, COLD REGIONS



FIGURE 2: A SECTION OF THE WIND TUNNEL AT NEW YORK UNIVERSITY. PHOTOGRAPH SHOWS THE ACCUMULATION PATTERN OF SIMULATED SNOW AROUND SCALED MODELS OF ARCTIC BUILDINGS AND SNOW FENCES.

RESEARCH, HAS CONTINUED TO DEVELOP AND ESTABLISH CRITERIA AND TECHNICAL GUIDANCE FOR SITE SELECTION, DESIGN, LAYOUT, CONSTRUCTION, AND MAINTENANCE OF CAMPS AND BASES TO MINIMIZE THE EFFECTS OF ENVIRONMENT IN COLD REGIONS, AND TO DEVELOP IMPROVED CRITERIA FOR DESIGN OF MATERIEL AND EQUIPMENT.

CORPS OF ENGINEERS EQUIPMENT AND MATERIALS ARE CONTINUING TO BE TESTED BOTH IN THE LABORATORY ENVIRONMENTAL FACILITIES AT USAERDL AND IN THE FIELD. YUMA TEST STATION IS USED FOR TESTING UNDER DESERT CONDITIONS; THE PANAMA CANAL ZONE IS USED FOR TROPICAL FACTORS; FORT CHURCHILL, ALASKA, AND GREENLAND ARE USED FOR SUBARCTIC AND ARCTIC ENVIRONMENT.

THE REALITY OF "CAMP CENTURY" AS CONSTRUCTED REQUIRED FURTHER LOGISTICS STUDIES TO BE MADE. AS A RESULT OF THIS STUDY A NEW AND RADICAL CONCEPT IN LOGISTICS WAS ENVISAGED FOR THE DEVELOPMENT OF UNDER-SNOW BUILDINGS. THIS CONCEPT OF FORMING BUILDINGS ON SITE FROM DRUMS OF POLYURETHANE FOAM-PLASTIC MATERIALS IS EXPECTED TO RESULT IN IMMENSE LOGISTIC SAVINGS (7).



FIGURE 3: ACCUMULATION PATTERN AROUND A MODEL OF A COMPOSITE DYE-SITE BUILDING. THIS TEST WAS CONDUCTED IN A SYNTHETIC ENVIRONMENT IN WHICH A PARTICULARLY HEAVY RATE OF "SNOWFALL" WAS INDUCED.

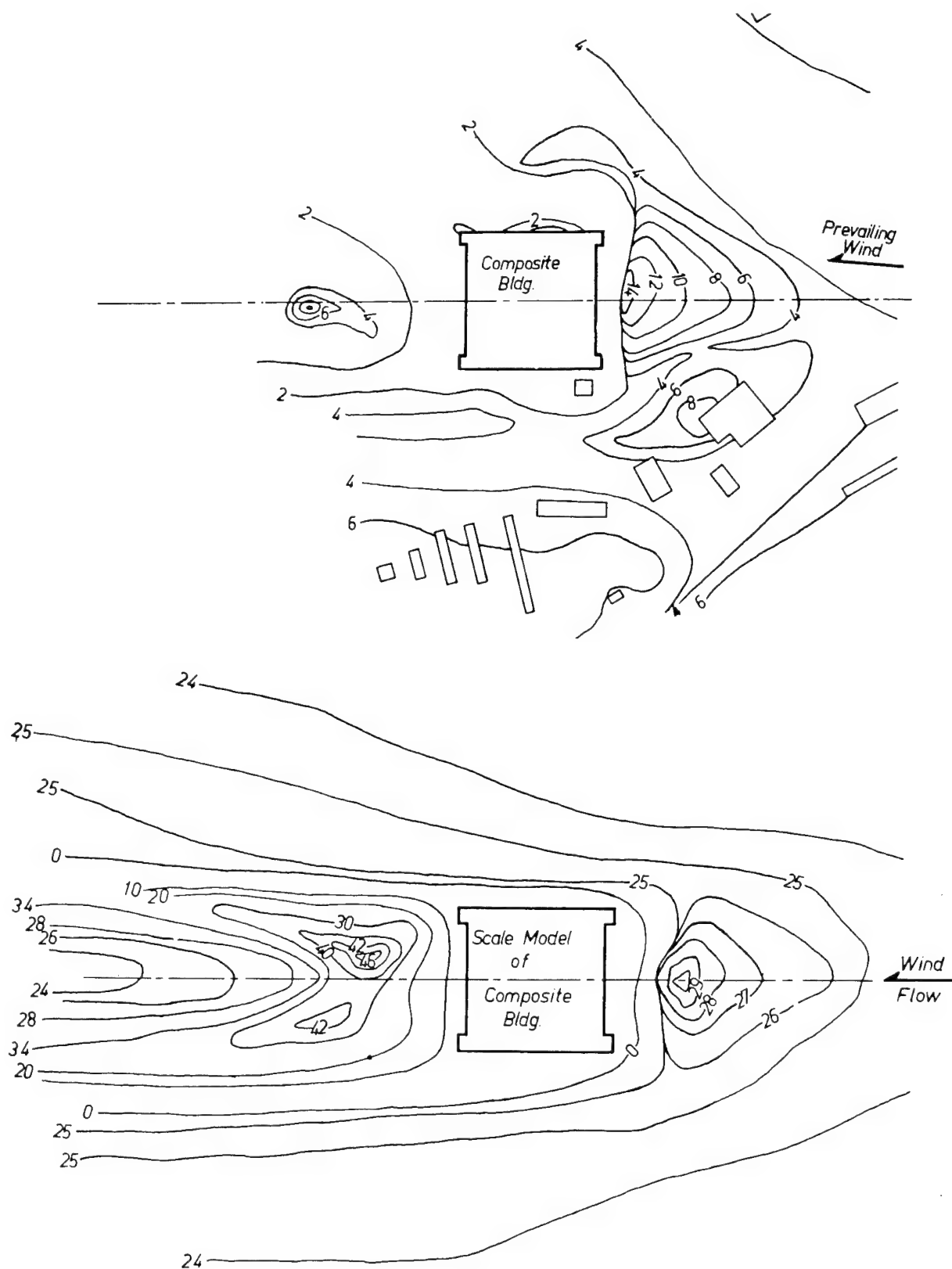


FIGURE 4: COMPARATIVE ACCUMULATION PATTERNS. UPPER DRAWING SHOWS A 10-MONTH ACCUMULATION OF NATURAL SNOW AROUND A DYE-SITE BUILDING. LOWER DRAWING SHOWS A SIMILAR PATTERN OF SIMULATED SNOW AROUND A MODEL STRUCTURE IN A WIND TUNNEL.

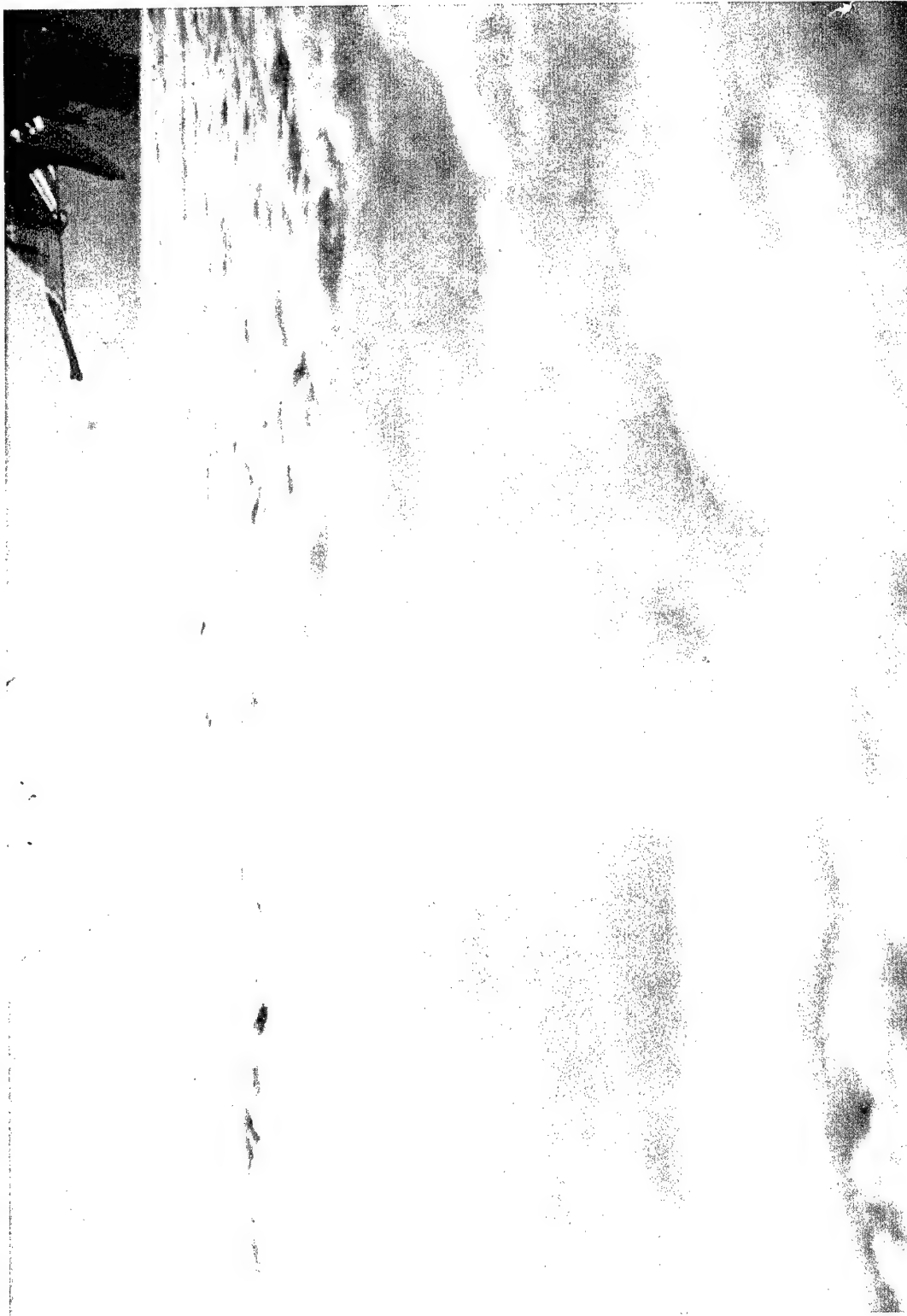


FIGURE 5: THIS PHOTOGRAPH SHOWS AN AREA WHICH WAS SEEDED WITH DRY-ICE ABOUT 25 MINUTES EARLIER. THE OPENING IN THE OTHERWISE SOLID CLOUD DECK IS LARGE AND CLEAR ENOUGH TO PERMIT AIRCRAFT TO DESCEND THROUGH WITHOUT THE USE OF INSTRUMENTS.



4. MEDICAL CORPS

DURING THE YEAR THE MEDICAL CORPS CARRIED ON PHYSIOLOGICAL RESEARCH ON EFFECTS OF LOW TEMPERATURES. HOWEVER, NO APPLIED ENVIRONMENTAL RESEARCH, AS DEFINED FOR THE PURPOSE OF THIS REPORT, WAS CONDUCTED.

## 5. ORDNANCE CORPS

### A. CLIMATIC FIELD TESTS

A LIMITED AMOUNT OF DATA IS OBTAINED THROUGH OBSERVATION OF USER TESTS MADE BY CONARC AND FROM REPORTS RECEIVED FROM COMBAT AREAS. IN THE NORTH ZONE ARCTIC TESTS, PARTICULAR ATTENTION IS PAID TO MOBILITY IN SOFT, DEEP SNOW, AND COLD STARTING AND WARM-UP OF VEHICLES. IN DESERT TESTS, ITEMS ARE TESTED FOR RESISTANCE TO DUST AND SAND, FOR ABILITY OF ENGINES TO OPERATE FREE OF VAPOR LOCK AND TO COOL PROPERLY, AND FOR MOBILITY IN THE SAND DUNES. TEST AGENCIES USED DURING THIS REPORTING PERIOD WERE AS FOLLOWS:

(1) U.S. ARMY ORDNANCE CLIMATIC TEST DETACHMENT, FORT CHURCHILL, MANITOBA, CANADA. ARMAMENT AND AMMUNITION ITEMS COMPRISED 18 PROGRAMS, AND AUTOMOTIVE MATERIEL COMPRISED 15 PROGRAMS.

(2) U.S. ARMY ORDNANCE TEST ACTIVITY, YUMA TEST STATION, YUMA, ARIZONA. ARMAMENT AND AMMUNITION ITEMS COMPRISED 13 PROGRAMS, AND AUTOMOTIVE MATERIEL COMPRISED 18 PROGRAMS.

(3) U.S. ARMY ARCTIC TEST BOARD, FORT GREELY, ALASKA. YUMA-TO-ALASKA 1960-61 WINTER OVERLAND CONVOY OPERATION (AND RETURN) WAS SUCCESSFULLY ACCOMPLISHED.

### B. INDEX OF ENVIRONMENTAL FACTORS

ABERDEEN PROVING GROUND (ORDBG-DP-DF) CONTINUED WORK ON THE BIBLIOGRAPHICAL INDEX KNOWN AS THE "ORDNANCE TECHNICAL INDEX OF ENVIRONMENTAL FACTORS," UNDER CONTRACT NO. DA-23-072-509-ORD-4 WITH THE SOUTHWEST RESEARCH INSTITUTE (ENVIRONMENTAL RESEARCH SECTION). SUPPLEMENTS TO PART II, "HOT;" PART III, "TROPICAL;" AND PART IV, "HIGH ALTITUDE" WERE PUBLISHED.

### C. ENVIRONMENTAL CHAMBERS

ENVIRONMENTAL CHAMBERS WERE ACQUIRED FOR USE AT ABERDEEN PROVING GROUND, COMPRISING SOLAR RADIATION, SAND AND DUST, SALT SPRAY, AND EXTREME TEMPERATURE (TWO EACH). THESE CHAMBERS ARE 10' DEEP BY 12' WIDE BY 10' HIGH, EXCEPT FOR THE SAND AND DUST WHICH IS 4' x 8' x 5'; ALL ARE TRANSPORTABLE AND WILL SUBJECT EXPLOSIVE OR INERT MATERIEL TO TESTS IN ACCORDANCE WITH MIL-E-5272C. PLANNING ACTION FOR RELOCATING ARCTIC TESTING FROM FORT CHURCHILL TO ALASKA IS CURRENTLY IN PROGRESS. USE OF THE NEW ARCTIC TEST SITE IN ALASKA IS PLANNED FOR THE 1961-62 TEST SEASON. SIZE OF TEST PROGRAM WILL BE DEPENDENT UPON PROGRESS AND COMPLETION OF REQUIRED TEST FACILITIES, AS WELL AS AVAILABILITY OF REQUIRED POST SUPPORT SERVICES WITHIN THE ALASKAN ARMY COMMAND.

### D. ENVIRONMENTAL RESEARCH

THE FORMER OOR ENVIRONMENTAL RESEARCH OFFICE, AS PROJECT MANAGER, CONTINUED AS AN ORDNANCE CORPS ACTIVITY RESPONSIBLE TO OCO (ORDTB) BUT

ADMINISTRATIVELY ATTACHED FOR THE REMAINDER OF FY 61 TO THE NEWLY DESIGNATED ARMY RESEARCH OFFICE (DURHAM). MAJOR INVESTIGATIONS BESIDES IN-HOUSE ACTIVITIES ARE INCLUDED IN PRIMARY CONTRACTS WITH THE SOUTHWEST RESEARCH INSTITUTE (ENVIRONMENTAL RESEARCH SECTION) AND THE STANFORD RESEARCH INSTITUTE (PHYSICS DEPARTMENT). FUNDING SUPPORT WAS PROVIDED FOR A CONTRACT WITH CORNELL AERONAUTICAL LABORATORY THROUGH THE U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, CORPS OF ENGINEERS. ACTIVITIES DURING THE PAST YEAR HAVE INCLUDED THE FOLLOWING:

(1) DETERMINATION OF THE ENVIRONMENTAL FACTORS (FOR ORDNANCE CORPS MATERIEL) EXISTING IN A WET TROPICAL ENVIRONMENT. THIS HAS INCLUDED LIAISON WITH SCIENTIFIC OBSERVERS ON TREOG FIELD EXPEDITIONS IN PANAMA DURING 1960 AND 1961. PROGRESS REPORTS ARE BEING PREPARED.

(2) EXPERIMENTATION TO PROVIDE DATA FOR FORMULATING A STANDARDIZED SAND TEST PROCEDURE. THIS INCLUDES COORDINATION OF ORDNANCE EFFORTS THROUGH THE WHITE SANDS MISSILE RANGE, FRANKFORD ARSENAL, ABERDEEN PROVING GROUND, PICATINNY ARSENAL, AND THE TANK-AUTOMOTIVE COMMAND, UNDER A DOD ASSIGNMENT.

(3) INVESTIGATIONS RELATING TO SYNERGISTIC EFFECTS IN COMBINED ENVIRONMENTS TESTING (3).

(4) APPLICATION OF FINDINGS OF THE CORPS OF ENGINEERS "WHITE-OUT" INVESTIGATION TO DEVELOP PROJECTILE DEVICES AND TECHNIQUES FOR DISPERSION.

## 6. QUARTERMASTER CORPS

### A. APPLICATIONS OF ENVIRONMENTAL RESEARCH

RECENT CHANGES IN THE POLITICAL STATUS AND NAMES OF LARGE PORTIONS OF AFRICA AND OTHER PARTS OF THE WORLD NECESSITATED A REVISION OF THE GEOGRAPHIC SECTION, PART 6, OF TA 21 (PEACE), CLOTHING AND EQUIPMENT, AND THE COMPANION DOCUMENT, TA 21 (MOBILIZATION). THE COMPLETE TEXT AND TABLES OF TA 21 (PEACE) ARE CURRENTLY UNDER REVISION BY THE ARMY CLOTHING AND TEXTILE MATERIEL CENTER, PHILADELPHIA.

WORK HAS CONTINUED TOWARD REFINING THE MOUNTAIN CLASSIFICATION SYSTEM USED IN THESE DOCUMENTS, WITH A VIEW TOWARD (A) REDUCING THE AMOUNT OF TIME REQUIRED BY PLANNING AND SUPPLY PERSONNEL IN DETERMINING CLOTHING AND PERSONNEL EQUIPMENT REQUIREMENTS FOR THESE AREAS, (B) ELIMINATING THE TRANSPORTATION AND STORAGE OF SPECIALIZED EQUIPMENT IN LOCATIONS WHERE IT IS NOT NEEDED, AND (C) ASSURING THAT ITEMS ARE AVAILABLE WHERE AND WHEN REQUIRED IN ORDER TO EFFECT GREATER ECONOMY IN THE SUPPLY SYSTEM.

WORK CONTINUED ON ONE OF A SERIES OF REPORTS DESIGNED TO COORDINATE RESULTS OF RESEARCH IN VARIOUS FIELDS AND APPLY THE FINDINGS TO A PARTICULAR REGION. THE CURRENT REPORT USES THE ENTIRE AFRICAN CONTINENT AS THE REGION OF APPLICATION FOR NEW FINDINGS. AS IN MOST OF SOUTHWEST ASIA, MUCH OF AFRICA (ABOUT ONE-THIRD) IS SEASONALLY HOT DESERT, AND MOST OF THE MILITARY PROBLEMS ARE THOSE COMMON TO OTHER DESERT AREAS. THERE ARE ALSO LARGE AREAS OF TROPICAL FOREST, AND PROBLEMS OF TRANSPORTATION AND COMMUNICATION ARE PARAMOUNT. THE REPORT INCLUDES MAPS SHOWING REGIONAL REQUIREMENTS WITHIN AFRICA FOR QMC ITEMS SUCH AS CLOTHING AND FIELD SLEEPING GEAR (FIG. 6). OTHER MAPS SHOW APPLICATIONS OF INFORMATION PROVIDED BY A COMPLETED CONTRACT ON THE DISTRIBUTION OF INSECTS AND THEIR RESISTANCE TO THE STANDARD MILITARY INSECTICIDES.

A DRAFT COPY OF RECOMMENDED REVISIONS TO AR 705-15, ENTITLED POLICIES AND IMPLEMENTATION PROCEDURES FOR ENVIRONMENTAL DESIGN CRITERIA AND TESTING, WAS PREPARED WITH THE COOPERATION OF REPRESENTATIVES FROM EACH TECHNICAL SERVICE, USCONARC, AND MEMBERS OF THE ARMY COMMITTEE ON ENVIRONMENT, PANEL ON ENVIRONMENTAL RESEARCH.

HIGHLIGHTS OF THE SUGGESTED REVISION INCLUDE LIMITATION OF THE AR TO ENVIRONMENTAL POLICIES AND THEIR IMPLEMENTATION AND THE RECOMMENDATION THAT SPECIFIC CRITERIA, OPERATIONAL AREAS, AND OTHER BACKGROUND DATA BE PUBLISHED AS A SERIES OF DOCUMENTS SUPPLEMENTAL TO THE AR. FIVE SUPPLEMENTAL DOCUMENTS HAVE BEEN PROPOSED COVERING: (1) MILITARY GEOGRAPHIC AREAS, CONSISTING OF DESCRIPTIONS AND DESIGN CRITERIA FOR GLOBAL OPERATIONAL AREAS; (2) ATMOSPHERIC AREAS, CONSISTING OF DESCRIPTIONS AND DESIGN CRITERIA FOR OPERATION WITHIN THE VERTICAL LAYERS FROM THE TROPOSPHERE TO THE EXOSPHERE AT THE THRESHOLD OF SPACE; (3) INDUCED ENVIRONMENTS, CONSISTING OF PARAMETERS OF MAN- OR EQUIPMENT-MADE STRESSES THAT VARY WITH FUNCTION, TYPE OF EQUIPMENT, LOCATION, AND TIME; (4) TEST METHODS AND PROCEDURES, CONSISTING OF THE PHILOSOPHY OF TESTING AND ACTUAL TESTS

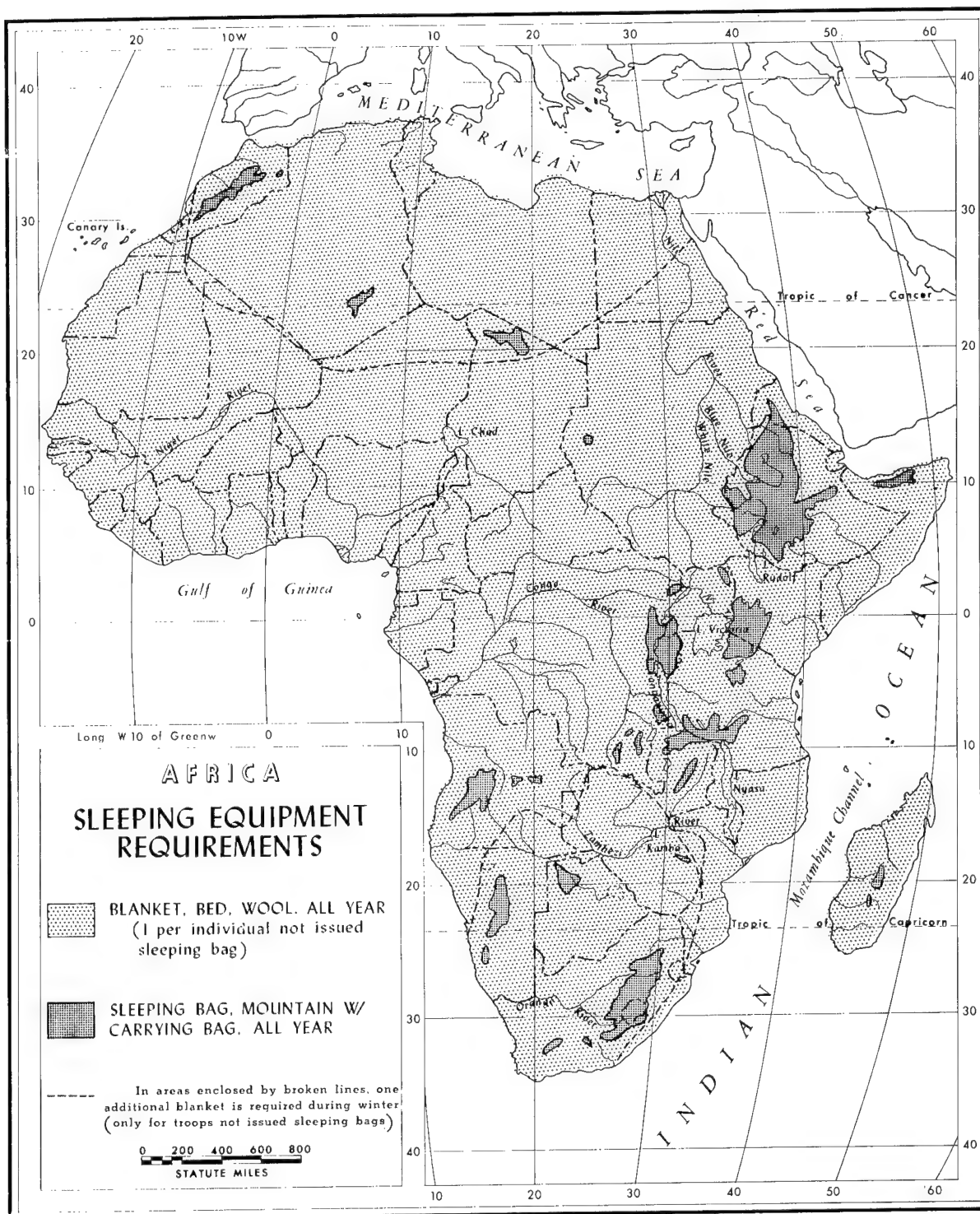


FIGURE 6

AND TEST METHODS; AND (5) FIELD PERFORMANCE OF EQUIPMENT, CONSISTING OF DOCUMENTATION OF THE PERFORMANCE CAPABILITIES OF CRITICAL ITEMS OF EQUIPMENT AND MATERIEL UNDER ANY CONDITION OF GLOBAL ENVIRONMENT.

A QUALITATIVE MATERIEL DEVELOPMENT OBJECTIVE (QMDO) APPLICABLE TO THE ENVIRONMENTAL RESEARCH PROGRAMS OF ALL THE TECHNICAL SERVICES AND COVERING THE NEED FOR MORE EXTENSIVE AND MORE RELIABLE ENVIRONMENTAL DATA IN DEVELOPING AND EVALUATING FUTURE EQUIPMENT WAS SUBMITTED TO CG, USCONARC, FOR INCLUSION IN THE COMBAT DEVELOPMENT OBJECTIVES GUIDE, BY THE PRESIDENT OF THE QUARTERMASTER BOARD.

A FINAL DRAFT OF THE PROPOSED MILITARY STANDARD: ENVIRONMENTAL TERMINOLOGY FOR DESIGN, DEVELOPMENT AND TESTING, PROJECT No. MISC-0014, WAS CIRCULATED AMONG BUREAUS, DIVISIONS, AND TECHNICAL SERVICES OF DOD FOR FINAL COORDINATION. PREPARING ACTIVITY IS BUREAU OF WEAPONS D/N; CUSTODIAN FOR D/A IS THE QUARTERMASTER CORPS.

#### B. ARCTIC ENVIRONMENTS

STUDIES OF THE NATURAL ENVIRONMENT IN THE ARCTIC AND ADJACENT SUBARCTIC AREAS CONTINUED FOR THE PURPOSE OF BETTER DEFINING THE SEASONAL AND AREAL REQUIREMENTS FOR VARIOUS QUARTERMASTER ITEMS. STUDIES WERE ALSO UNDERTAKEN AT THE REQUEST OF OTHER DEFENSE AGENCIES, IN ACCORDANCE WITH QUARTERMASTER CORPS' ASSIGNED COGNIZANCE FOR SUCH RESEARCH.

FOLLOWING PUBLICATION OF A REPORT ON THE ENVIRONMENT OF SOUTHEAST GREENLAND (10), THE SECOND STUDY IN THE GREENLAND SERIES WAS COMPLETED. THIS REPORT, WHICH IS BEING PREPARED FOR PUBLICATION, SUMMARIZES THE ENVIRONMENT OF THE ICE CAP. IT IS BASED ON PUBLISHED DATA FROM A WIDE VARIETY OF SOURCES IN SEVERAL LANGUAGES, AS WELL AS ON FIELD OBSERVATIONS BY A QUARTERMASTER OBSERVER WHO PARTICIPATED IN THE TRANSPORTATION CORPS EXERCISE "LEAD DOG 60," FROM TUTO TO LAKE CENTRUM IN NORTHEAST GREENLAND.

A SERIES OF MAPS DEPICTING VARIOUS ASPECTS OF ARCTIC ENVIRONMENT WAS PREPARED AND PUBLISHED IN ATLAS FORM AT THE REQUEST OF THE TERRESTRIAL SCIENCES LABORATORY, US AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (FIG. 7). THESE MAPS WERE DESIGNED ESPECIALLY FOR USE IN ASSESSING THE FEASIBILITY OF USING UNPREPARED LANDING SITES FOR WHEELED AIRCRAFT IN NORTHERN AREAS.

AN ADDITIONAL AREA OF COOPERATION BETWEEN THE ARMY AND AIR FORCE WAS IN THE CONDUCT OF EXPEDITIONS TO OBTAIN SCIENTIFIC DATA FROM REMOTE STATIONS IN ALASKA AND CANADA. ENLISTED SIGNAL CORPS PERSONNEL PARTICIPATED IN AIR FORCE EXPEDITIONS TO LAKE PETERS IN NORTHERN ALASKA AND WARD HUNT ISLAND ON THE ELLESMERE ICE SHELF, TO OBTAIN CLIMATIC DATA FOR THE QUARTERMASTER CORPS.

A STUDY OF THE GEOGRAPHICAL ASPECTS OF MUSKEG AS RELATED TO MOVEMENT OF MILITARY UNITS AND SUPPLIES WAS COMPLETED AT THE REQUEST OF THE TRANSPORTATION CORPS. THE STUDY INCLUDED: A BIBLIOGRAPHIC SURVEY OF SCIENTIFIC AND TECHNICAL PUBLICATIONS DEALING WITH THE CLASSIFICATION AND DISTRIBUTION OF MUSKEG IN NORTH AMERICA AND EQUIVALENT TERRAIN TYPES



IN EURASIA; A PARTIAL TRANSLATION OF A BASIC RUSSIAN WORK ON "PEAT-FORMING AREAS" (MUSKEG); EVALUATION OF VARIOUS SYSTEMS FOR CLASSIFYING MUSKEGS; PREPARATION OF A MAP OF REGIONS WHERE MUSKEG MIGHT CONSTITUTE A MILITARY PROBLEM; A REVIEW OF THE STATUS OF PHOTOINTERPRETATION AS APPLIED TO PROBLEMS OF TRAFFICABILITY IN MUSKEG; AND RECOMMENDATIONS FOR FUTURE LINES OF RESEARCH ON THE PROBLEM.

#### C. CLIMATIC ANALOG STUDIES

THE COMPARISON OF THE CLIMATE OF THE ARMY'S MAJOR TESTING SITES WITH THAT OF OTHER PARTS OF THE WORLD CONTINUED. DURING THE YEAR THE QUARTERMASTER CORPS PUBLISHED THE FINAL TWO CLIMATIC ANALOG STUDIES IN THE TROPICAL SERIES, COMPARING TROPICAL CLIMATIC CONDITIONS IN THE FAR EAST (1) AND IN THE PACIFIC ISLANDS (5) WITH THOSE IN THE PANAMA CANAL ZONE.

AT THE REQUEST OF THE QUARTERMASTER, US ARMY PACIFIC, TWO ADDITIONAL STUDIES WERE PUBLISHED COMPARING THE ENVIRONMENT OF THE REPUBLIC OF PANAMA (27) AND SOUTHEAST ASIA (6) WITH THE ENVIRONMENT OF THE ISLAND OF HAWAII.

CLIMATIC ANALOG STUDIES WERE COMPLETED FOR DESERTS IN SOUTH AMERICA (35), SOUTH AFRICA (26), AND AUSTRALIA (2), EXTENDING THE COMPARISON OF YUMA CLIMATE TO DESERTS IN THE SOUTHERN HEMISPHERE. PUBLICATION OF THESE STUDIES WILL COMPLETE THE CLIMATIC ANALOG PROGRAM.

#### D. CLIMATIC FREQUENCY STUDIES

MCGILL UNIVERSITY COMPLETED A CONTRACT TO ANALYZE AND PUBLISH TEMPERATURE AND WIND FREQUENCY DATA. PUBLICATION OF THE DATA WAS COMPLETED WITH THE 4TH VOLUME FOR EURASIA (15) AND TWO VOLUMES FOR NORTH AMERICA AND GREENLAND (16). FREQUENCY DATA FOR 137 NORTH AMERICAN AND 203 EURASIAN STATIONS ARE GIVEN IN THE SIX VOLUMES OF TABLES. EACH TABLE INCLUDES FREQUENCIES OF TEMPERATURE AND WINDSPEED BY 5-DEGREE TEMPERATURE CLASSES AND BEAUFORT WINDSPEED CLASSES.

ATLASES OF SURFACE TEMPERATURE FREQUENCIES FOR NORTH AMERICA AND GREENLAND AND FOR EURASIA WERE ALSO PUBLISHED (17, 18). FOR EACH MONTH, MAPS WERE PREPARED TO SHOW PERCENTAGE OF TIME THAT THE RECORDED TEMPERATURES ARE BELOW -50°, -40°, -25°, 0°, 15°, 32°, 50°, 70°, 85°, AND 100°F (FIG. 8). ISOPLETHS ARE DRAWN FOR EACH 10-PERCENT INTERVAL OF OCCURRENCE. THE FINAL VOLUME, "INDEX AND ANALYSIS OF SURFACE TEMPERATURE AND WIND FREQUENCY DATA," CONTAINS A LIST OF STATIONS AND SUPPLEMENTARY INFORMATION ON THE DATA USED IN PREPARING THE FREQUENCY ATLASES. WINDSPEED FREQUENCY MAPS FOR NORTH AMERICA AND EURASIA FOR EACH MONTH WERE DRAFTED IN FINAL FORM.

TRIVARIATE SUMMARIES OF TEMPERATURE, DEWPOINT, AND WINDSPEED FOR 197 STATIONS IN LOW LATITUDES WERE TABULATED BY THE AIR WEATHER SERVICE, U.S.A.F. PREPARATION OF ADDITIONAL TABULATIONS IS IN PROGRESS.



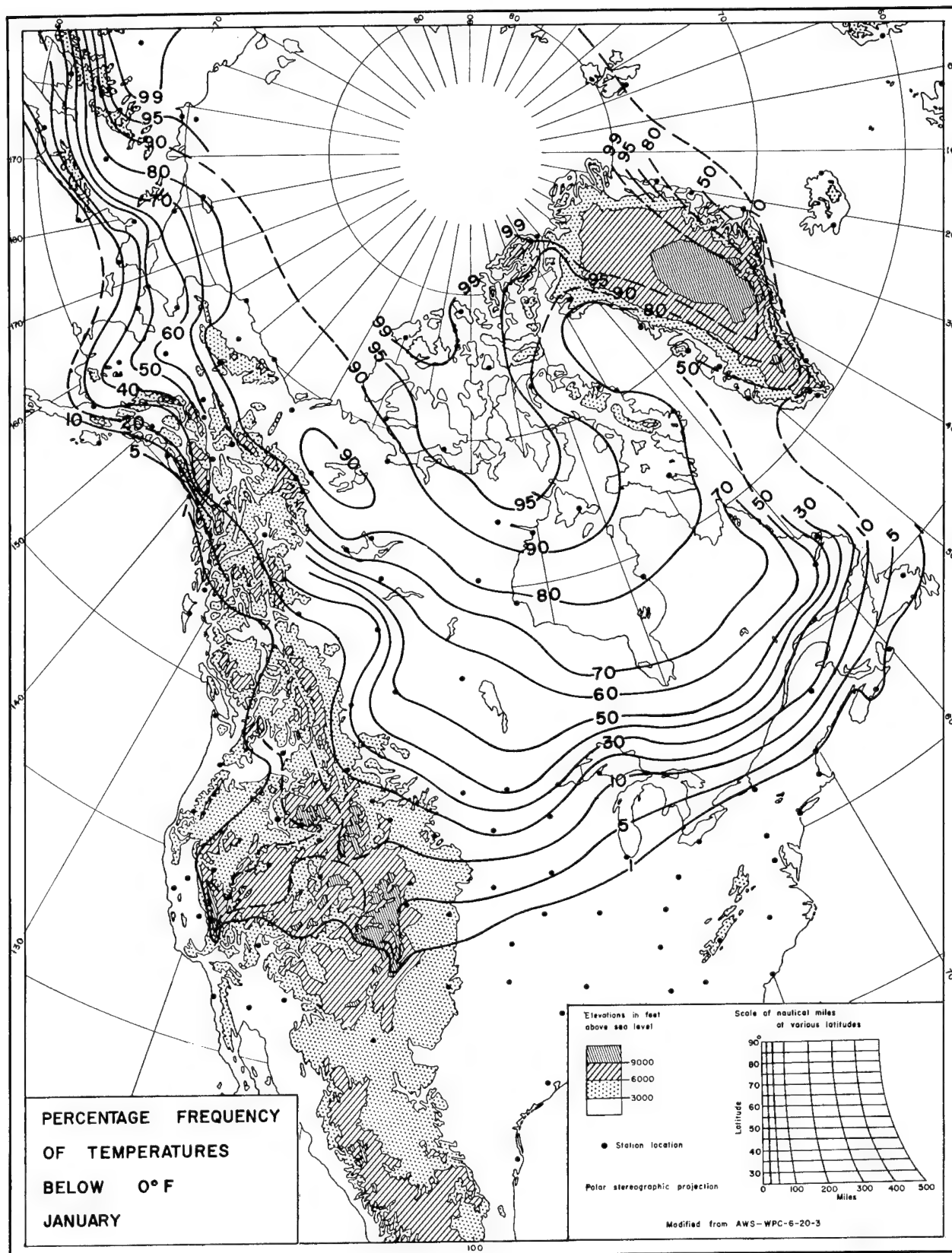


FIGURE 8

THE RESULTS OF PREVIOUSLY REPORTED STUDIES OF METHODS OF PREDICTING FREQUENCY DISTRIBUTIONS OF TEMPERATURE AND WINDCHILL WERE PUBLISHED (40). THE METHOD OF DETERMINING THE FREQUENCY OF DAILY MINIMUM TEMPERATURES FROM KNOWN VALUES OF ABSOLUTE MINIMUM, MEAN DAILY MINIMUM, AND ABSOLUTE MAXIMUM TEMPERATURES WAS FURTHER TESTED AND WAS FOUND TO BE ACCURATE TO WITHIN 5 F DEGREES AT ALL PERCENTILE LEVELS EXCEPT THOSE INCLUDED IN THE 3 OR 4 WARMEST DAYS OF EACH MONTH. A SIMILAR METHOD USING THE ABSOLUTE MAXIMUM, MEAN DAILY MAXIMUM, AND ABSOLUTE MINIMUM HAS BEEN DEVELOPED FOR PREDICTING THE STATISTICAL DISTRIBUTION OF DAILY MAXIMA. THIS METHOD IS UNDERGOING TEST AND WILL PROBABLY PROVE AS ACCURATE AS THE ONE FOR PREDICTING FREQUENCY DISTRIBUTIONS OF DAILY MINIMA.

#### E. FOOD GEOGRAPHY

A CONTRACT WITH THE AMERICAN GEOGRAPHICAL SOCIETY TO PREPARE AN ANALYSIS OF THE FOOD RESOURCES OF SOUTHERN ASIA AND NORTHERN AFRICA WAS VIRTUALLY COMPLETED DURING THE YEAR. ADVANCE COPIES OF THE FINAL REPORT, ENTITLED FOOD: RESOURCES, HABITS, AND DEFICIENCIES; PART I, THE FAR EAST; PART II, THE NEAR EAST AND EGYPT, WERE RECEIVED, REVIEWED, AND CLEARED FOR PUBLICATION. THE REPORT CONSISTS OF SEPARATE ANALYSES OF THE FOOD RESOURCES OF COMMUNIST CHINA, TAIWAN, VIETNAM, CAMBODIA, LAOS, THAILAND, MALAYA, BURMA, INDIA, CEYLON, PAKISTAN, AFGHANISTAN, IRAN, IRAQ, SAUDI ARABIA, SYRIA, LEBANON, ISRAEL, TURKEY, AND EGYPT. FOR EACH COUNTRY, UP-TO-DATE INFORMATION HAS BEEN DEVELOPED ON: THE KINDS, AMOUNTS, AND SUFFICIENCY OF FOOD (ANIMAL AND VEGETABLE) PRODUCED IN AN AVERAGE YEAR; DIET TYPES BY CLASS AND REGIONAL DIFFERENCES; THE FOOD IMPORTS AND EXPORTS IN AN AVERAGE YEAR; THE VULNERABILITY OF THE DIETARY STRUCTURE TO ENVIRONMENTAL HAZARDS AND HUMAN CATASTROPHES SUCH AS EPIDEMICS OR WAR; METHODS OF FOOD PROCESSING, STORAGE, AND PACKING; AND HEALTH AND/OR PHYSICAL DISABILITIES THAT MAY RESULT FROM DIETARY INADEQUACIES AND PRACTICES. PUBLISHED COPIES OF THE FINAL REPORT WILL BE AVAILABLE FOR DISTRIBUTION BY 30 DECEMBER 1961.

THE INFORMATION PROVIDED CAN BE USED IN PLANNING FOR THE FEEDING OF BOTH MILITARY PERSONNEL AND CIVILIANS IN TIME OF WAR AND IN DISTRIBUTING FOOD SURPLUSES ABROAD IN TIMES OF ENVIRONMENTAL DISASTER SUCH AS EPIDEMICS AND FLOODS.

#### F. HUMAN ENVIRONMENTS

A CONTRACT WAS COMPLETED BY THE NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL, REVIEWING EXISTING KNOWLEDGE ON NATURAL AND HUMAN CONDITIONS THAT MIGHT AFFECT AMERICANS IN CENTRAL AFRICA, AND POINTING OUT PRESENT SCIENTIFIC GAPS REQUIRING FURTHER INVESTIGATION. A DOZEN TECHNICAL ARTICLES OR BOOKS WERE PUBLISHED OR ARE IN PRESS, GIVING NEW AND FRESH UNDERSTANDING OF SUCH ASPECTS OF CENTRAL AFRICA AS INDIGENOUS MARKETS, WAYS OF COMMUNICATING NEWS OR IDEAS, DISTRIBUTION OF FOOD CROPS (22), SEASONAL PROBLEMS IN TRANSPORTATION, CITY FOOD PROBLEMS, LAND TENURE SYSTEMS, PSYCHOLOGICAL PRESSURES AFFECTING AFRICAN ATTITUDES TODAY (9), LABOR PROBLEMS, AND RELATIONSHIPS TO ENVIRONMENTAL CONDITIONS.

A FINAL REPORT WAS PUBLISHED IN TWO PARTS, THE FIRST SUMMARIZING THE FINDINGS AND RECOMMENDATIONS OF THE SENIOR SCIENTISTS REPRESENTING DIVERSE FIELDS OF KNOWLEDGE, AND THE SECOND POINTING OUT IMPLICATIONS FOR AMERICANS WHO MIGHT HAVE CONTACTS WITH AFRICAN PEOPLE (23).

VALUABLE BY-PRODUCTS OF THE CONTRACT, AVAILABLE FOR REFERENCE AT THE QM R&E CENTER, NATICK, MASS., INCLUDE EXTENSIVE CARD FILES COVERING ALL ASPECTS OF TEN REPRESENTATIVE TRIBES OF CENTRAL AFRICA, AND 2,000 SUMMARY SHEETS UPON WHICH A LEADING ETHNOLOGIST HAS COLLATED THE BASIC FACTS ABOUT THE 600-ODD TRIBES THROUGHOUT AFRICA.

AN ANALYTICAL SURVEY OF AFRICAN BURDEN-CARRYING SYSTEMS AND DEVICES WAS COMPLETED UNDER CONTRACT WITH THE HUMAN RELATIONS AREA FILES, INC. DATA FROM THIS SURVEY WILL DETERMINE AND CONTRAST EFFICIENCY CHARACTERISTICS OF BURDEN-CARRYING SYSTEMS AND APPRAISE THE LOGISTICS POTENTIAL.

THE FINAL REPORT, A SURVEY OF HUMAN BURDEN-CARRYING IN SUB-SAHARAN AFRICA, PRESENTS THE FIRST SYNTHETIC SURVEY OF BURDEN-CARRYING IN AFRICA, COVERING 177 REPRESENTATIVE TRIBES AND DELIMITING POSITIONS AND AVERAGE LOADS FOR THESE GROUPS. THE REPORT IS DIVIDED INTO FOUR MAJOR GROUPS. THE FIRST SECTION DESCRIBES, BY MEANS OF MAPS, THE GEOGRAPHICAL DISTRIBUTION OF 17 DISTINCTIVE TYPES OF HUMAN BURDEN-CARRYING IN SUB-SAHARAN AFRICA; THE SECOND SECTION DESCRIBES THE PHYSICAL ASPECTS OF BURDEN-CARRYING IN AFRICA (TECHNIQUES, SKILLS, CAPABILITIES, LIMITATIONS, ETC.); THE THIRD SECTION ANALYZES THE ECONOMIC AND ECOLOGICAL CONTEXT OF BURDEN-CARRYING AS IT OCCURS IN EACH OF 12 TRIBES SCATTERED THROUGHOUT TROPICAL AFRICA; THE FOURTH SECTION DISCUSSES ORGANIZED PORTERAGE WHICH WAS NOT INDIGENOUS IN AFRICA BUT WAS LARGELY A PRODUCT OF ARAB AND EUROPEAN CONTACTS.

#### G. MACHINE STORAGE OF CLIMATIC AND GEOGRAPHIC DATA

A SYSTEM HAS BEEN DEVISED FOR MACHINE STORAGE (BY DEGREE QUADRANGLE OF WORLD LAND AREA) OF MILITARILY SIGNIFICANT CLIMATIC AND GEOGRAPHIC DATA. WHEN CODING OF SUCH DATA IS COMPLETED THE SYSTEM WILL PERMIT RAPID EXTRACTION AND UTILIZATION OF REQUIRED INFORMATION. CODING OF AVAILABLE DATA FOR GREENLAND, CENTRAL EUROPE, AND CENTRAL AFRICA WAS COMPLETED AND EAM CARDS ARE BEING PREPARED FOR THE UNITED STATES AND PARTS OF NORTH AFRICA. THIS WORK IS BEING CONDUCTED BOTH IN-HOUSE AND BY CONTRACT.

ASSISTANCE BY US ARMY RESERVE R&D UNITS HAS CONTINUED. NINETY-TWO RESERVISTS HAVE COMPLETED AN INDOCTRINATION COURSE AT THE QM R&E CENTER, NATICK, MASS.; 11 UNITS AND 55 INDIVIDUAL RESERVISTS ARE ACTIVELY PARTICIPATING IN THE PROGRAM BY PLOTTING AND ANALYZING MAPS AND CODING THE DATA.

A MACHINE METHOD FOR CONVERTING MEAN MONTHLY WINDSPEED AND TEMPERATURE INTO PERCENTILE FREQUENCIES OF WINDCHILL HAS BEEN COMPLETED; THIS METHOD WILL UTILIZE DATA ALREADY IN THE SYSTEM AND WILL PRODUCE WINDCHILL-FREQUENCY CARDS FOR THE STORAGE DECK WITHOUT HAND TABULATION OR PUNCHING (40).

#### H. MESOCлимATIC RESEARCH

A STUDY OF TEMPERATURE DIFFERENCES IN THE VICINITY OF FORT GREELY, ALASKA, WAS INITIATED. THE MEASUREMENTS WERE TAKEN BY THE SIGNAL CORPS IN 1956-57 AT A NETWORK OF 25 STATIONS REPRESENTING THE MAJOR TERRAIN TYPES IN THE AREA. SIGNIFICANT DIFFERENCES BETWEEN TEMPERATURE REGIMES OF PROTECTED AND EXPOSED SITES HAVE BEEN FOUND.

MEASUREMENTS BY VOLUNTEER OBSERVERS, USING EQUIPMENT PROVIDED BY THE QUARTERMASTER CORPS UNDER NO-COST LOAN AGREEMENTS, WERE MADE AT SEVERAL STATIONS IN THE VICINITY OF THE QUARTERMASTER RESEARCH & ENGINEERING CENTER IN MASSACHUSETTS. AS THESE OBSERVATIONS REFLECT THE INFLUENCE OF LOCAL TERRAIN ON THE CLIMATE AS OBSERVED UNDER STANDARD CONDITIONS, THEY WILL ENABLE QUARTERMASTER CLIMATOLOGISTS TO ANSWER INQUIRIES CONCERNING LOCAL VARIATIONS IN THE CLIMATE OF THE AREA.

THE INSTITUTE OF ARCTIC AND ALPINE RESEARCH, UNIVERSITY OF COLORADO, CONCLUDED OBSERVATIONS UNDER A NO-COST AGREEMENT WITH THE QUARTERMASTER CORPS. OVER A 10-YEAR PERIOD, THIS AND PRECEDING CONTRACTS HAVE YIELDED CONTINUOUS DATA FROM A SERIES OF STATIONS AT VARIOUS ELEVATIONS IN THE FRONT RANGE OF THE ROCKY MOUNTAINS. SCIENTISTS AT THE INSTITUTE HAVE APPLIED THE DATA IN STUDIES OF THE INTERRELATIONSHIPS BETWEEN CLIMATIC ELEMENTS, ALTITUDE, FALLOUT, INSECT LIFE, AND VEGETATION (14). SUMMARIZATION AND APPLICATION OF THE DATA ARE BEING CONTINUED.

#### I. MICROCLIMATIC RESEARCH

REDUCTION AND ANALYSIS OF MICROMETEOROLOGICAL MEASUREMENTS TAKEN BY THE QMC AS PART OF THE USNC-IGY GLACIOLOGY PROGRAM AT LITTLE AMERICA V (1957) AND AT THE SOUTH POLE (1958) ARE BEING ACCOMPLISHED AT THE QMR&E CENTER THROUGH A NATIONAL SCIENCE FOUNDATION GRANT ADMINISTERED BY THE OHIO STATE UNIVERSITY RESEARCH FOUNDATION. REDUCTION OF THE DATA ONTO EAM CARDS WAS COMPLETED DURING THE PAST YEAR (FIG. 9). THE DATA ANALYSIS PROGRAM, DIRECTED TOWARD DETERMINING THE ENERGY EXCHANGES BETWEEN THE SNOW AND THE ATMOSPHERE, IS CONTINUING. IT HAS BEEN FOUND THAT TEMPERATURES AT THE 2-METER HEIGHT AT THE SOUTH POLE RANGED FROM 5.5°F TO -102.8°F. THE MINIMUM SURFACE TEMPERATURE WAS -103°F. THE LARGEST INVERSION FROM THE SURFACE TO 8 METERS WAS 26°F. WINDSPEEDS WERE CONSISTENTLY HIGH WITH A MAXIMUM GUST OF 42 KNOTS. LITTLE AMERICA V WAS FOUND TO HAVE A Milder CLIMATE THAN THAT AT THE SOUTH POLE. THE TEMPERATURE RANGED FROM 29°F TO -61°F. TEMPERATURE INVERSIONS WERE LARGER IN THE ENVIRONMENTAL LAYER: 34°F FROM THE SURFACE TO 8 METERS AND 25°F FROM THE SURFACE TO 2 METERS. THE AVERAGE WINDSPEED WAS LOWER THAN THAT AT THE SOUTH POLE, ALTHOUGH GUSTS UP TO 75 MPH WERE EXPERIENCED. PRELIMINARY RESULTS OF THE PROGRAM WERE PRESENTED AT MEETINGS OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS, HELSINKI, FINLAND, AND THE INTERNATIONAL GEOGRAPHICAL UNION, STOCKHOLM, SWEDEN, DURING JULY AND AUGUST 1960 (49).

THE SIGNAL CORPS CONTINUED MICROCLIMATIC MEASUREMENTS AT MAYNARD QM TEST ACTIVITY AND COMPLETED MICROCLIMATIC OBSERVATIONS FOR THE QMC IN PUERTO RICO. THE DATA ARE CURRENTLY BEING ANALYZED.

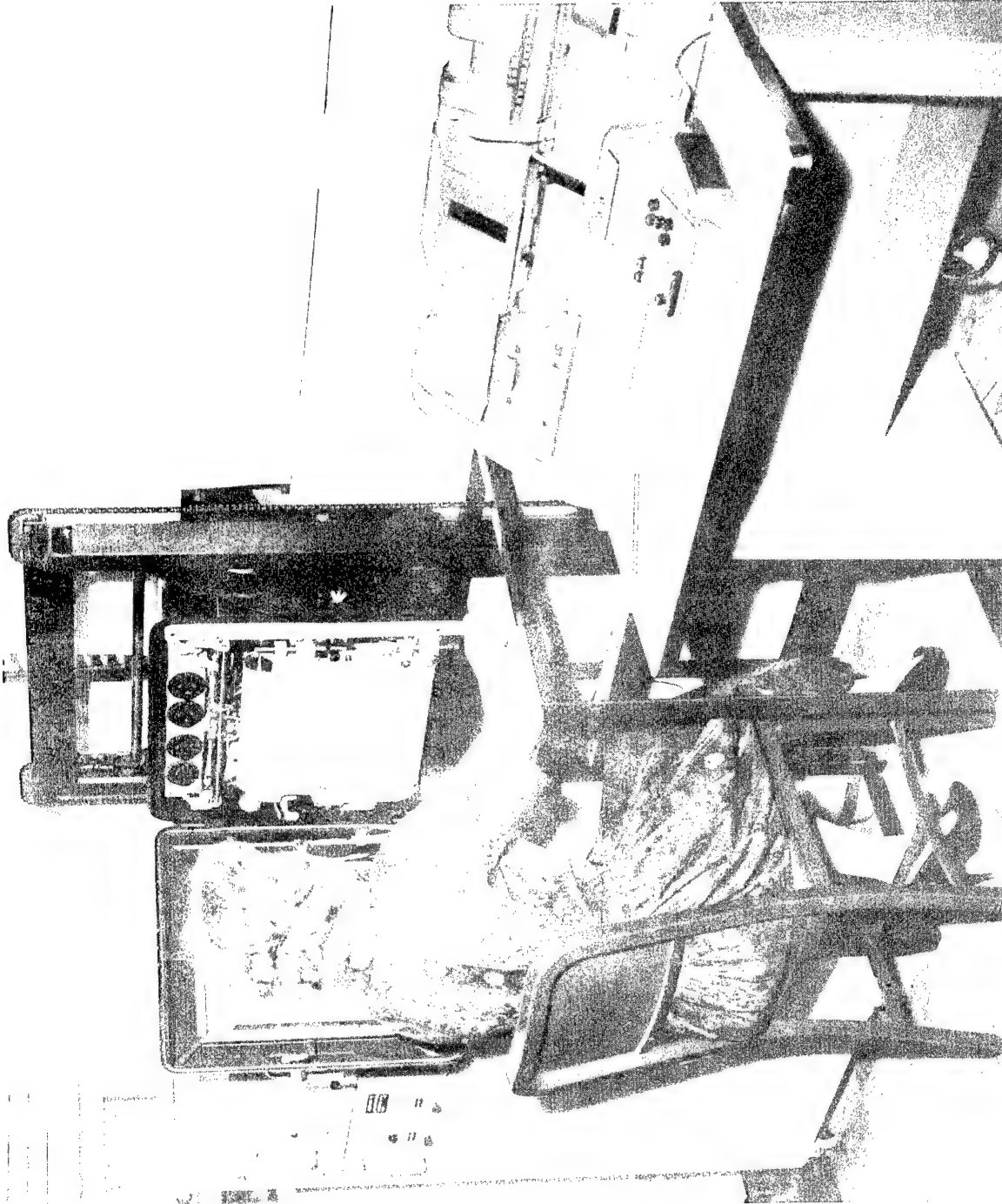


FIGURE 9: DATA REDUCTION SYSTEM FOR TRANSCRIPTION OF ANTARCTIC TEMPERATURE PROFILE MEASUREMENTS ONTO EAM CARDS, CONSISTING OF SCANNER, CONTROL CHASSIS, RECORDER, COMMUTATOR, AND KEY PUNCH.

## J. QUANTITATIVE TERRAIN ANALYSIS

RESEARCH IN THIS AREA IS BEING CONDUCTED BOTH BY CONTRACT AND IN-HOUSE. CONTRACT FUNDS HAVE BEEN MADE AVAILABLE BY DIRECT CITATION FROM THE ARMY VEHICLE ENVIRONMENTAL RESEARCH TEAM (AVERT), AN INTER-TECHNICAL SERVICE EFFORT FINANCED FOR THE MOST PART BY THE TRANSPORTATION CORPS.

A CONTRACT WITH MT. HOLYOKE COLLEGE IS CONCERNED WITH EVALUATION OF THE LINE-OF-SIGHT MODEL DESCRIBED IN LAST YEAR'S COGNIZANCE REPORT. THIS MODEL USES GENERALIZED MAP INFORMATION FOR PREDICTING THE NUMBER OF VALLEY BOTTOMS THAT WILL BE SEEN AT SPECIFIED DISTANCES FROM A HIGH POINT, IN TERMS OF PROBABILITIES BASED ON DATA CONCERNING SPACING AND DEPTHS OF VALLEYS AND HEIGHT OF THE OBSERVER POINT. THIS MODEL WAS "GAMED" IN SEVERAL DIFFERENT TERRAIN TYPES, AND BASIC INFORMATION WAS GATHERED RELATIVE OF 1 TO 20 MILES. IN ADDITION TO A FINAL REPORT SUGGESTING REVISIONS IN THE MODEL, THE CONTRACTOR WILL FURNISH BASIC DATA ON TERRAIN DIMENSIONS USEFUL IN FUTURE STUDIES.

A CONTRACT WITH CLARK UNIVERSITY CALLS FOR AN EXAMINATION OF THE UP-AND-DOWN COMPONENTS OF NAP-OF-THE-EARTH FLYING. SAMPLE CROSS-SECTIONS OF TERRAIN FROM EACH OF 25 PHYSIOGRAPHIC REGIONS OF THE UNITED STATES, AS THEY ARE REPRESENTED AT DIFFERENT SCALES OF MAPS AND AERIAL PHOTOGRAPHS, ARE TO BE ANALYZED. THE ANALYSIS WILL, FOR THE FIRST TIME, PROVIDE PRECISE DATA ON HOW EARTH CONFIGURATION BECOMES MORE AND MORE GENERALIZED AS THE SCALE OF REPRESENTATION BECOMES SMALLER. THIS, IN TURN, WILL PERMIT A PREDICTION OF THE ACTUAL TERRAIN CONDITIONS WHICH GOVERN FLYING AT VERY LOW ALTITUDES WHEN THE ONLY AVAILABLE INFORMATION IS CONTAINED ON A MEDIUM-SCALE MAP.

AN ANALYSIS OF DATA GATHERED AT A HUMRO EXERCISE AT CAMP CARSON, COLORADO, DESIGNED PRIMARILY TO TEST THE EFFICIENCY OF AERIAL OBSERVERS, WAS USED TO DETERMINE THE LENGTHS OF TIME AND THE RANGES AT WHICH THE OBSERVER-AIRCRAFT MIGHT HAVE BEEN EXPOSED TO ENEMY FIRE IF THIS HAD BEEN A MILITARY ACTION RATHER THAN AN EXERCISE. OBSERVERS WERE PLACED ON THE GROUND TO RECORD THE AZIMUTHS OF APPEARANCE AND DISAPPEARANCE OF THE AIRCRAFT AND THE AMOUNT OF TIME IT WAS IN VIEW (FIG. 10). PRINCIPLES PREVIOUSLY DISCOVERED WITH REGARD TO LINE OF SIGHT WERE APPLIED, AND THE THEORETICAL OUTCOME OF THE EXERCISE WAS FOUND TO AGREE CLOSELY WITH THAT WHICH ACTUALLY OCCURRED.

TWO CLOSELY RELATED STUDIES — GROUND-TO-GROUND LINE-OF-SIGHT RANGES, AND A STATISTICAL DISTRIBUTION OF RIDGE AND VALLEY SPACING — SHOW THAT THESE TWO TERRAIN DIMENSIONS ARE VERY SIMILAR FOR EVERY TERRAIN TYPE, IF INDIVIDUAL SPACINGS ARE FIRST DIVIDED BY THE MEAN FOR THE AREA (29, 42, 65). WORK IS IN PROGRESS TO DETERMINE METHODS FOR ESTIMATING THE AMOUNT OF AREA WHICH MAY BE KEPT UNDER SURVEILLANCE FROM A SINGLE POINT AND THE STATISTICAL DISTRIBUTION OF DEPTHS OF VALLEYS ALONG RANDOM TRAVERSES.

A STUDY WAS COMPLETED OF THE INTER-RELATIONSHIPS OF CLIMATE, SURFACE, AND VEGETATION OF THE NEW ENGLAND MOUNTAINS. THE RESULTS OF THIS STUDY

# 14 Cases - 50' Flight Altitude

Aircraft Speed - 100 MPH

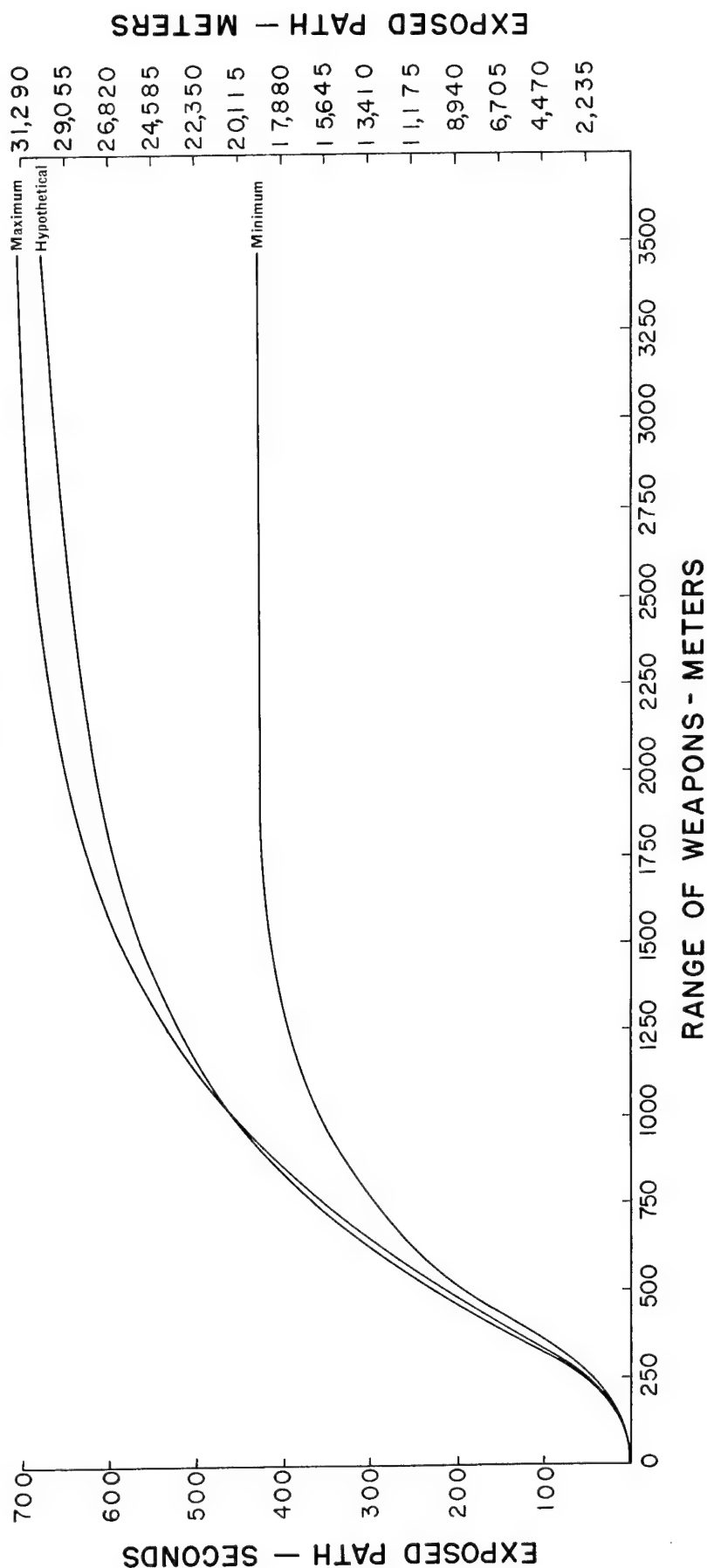


FIGURE 10: CUMULATIVE LENGTH OF EXPOSED PATHS TO RANGES OF WEAPONS. FLIGHT PATHS AND OBSERVER POSTS WERE PLOTTED ON A CONTOUR MAP AND LINES OF SIGHT PROJECTED FROM THE POSTS TO THE PATHS SO AS TO DIVIDE THEM INTO EXPOSED AND HIDDEN PORTIONS. WHEN REAL FLIGHTS WERE MADE OVER THESE SAME PATHS, OBSERV ON THE GROUND NOTED THE AZIMUTHS AT WHICH THE AIRCRAFT APPEARED AND DISAPPEARED. THE GRAPH SHOWS HOW WELL THE MAP ANALYSIS (HYPOTHETICAL) FORECASTS OF THE RANGES AND ELAPSED TIMES OF EXPOSURE AGREED WITH WHAT WAS ACTUALLY OBSERVED IN THE FIELD.

INDICATE THAT IT WILL BE POSSIBLE TO EXTEND THE PRINCIPLES DISCOVERED IN THIS WORK TO CONTRIBUTE TOWARD A NON-INSTRUMENTAL CLIMATOLOGY OF MOUNTAINS. THE SCARCITY OF CLIMATIC RECORDS FOR MOUNTAINOUS AREAS AS WELL AS THE ABUNDANCE OF BIOTIC AND GEOMORPHOLOGICAL KEYS TO CLIMATE SUGGEST THAT SUCH A STUDY WOULD BE USEFUL.

#### K. SOLAR RADIANT ENERGY STUDIES

MEASUREMENTS OF SOLAR AND TERRESTRIAL RADIATION RECEIVED ON A HORIZONTAL SURFACE CONTINUED AT NATICK, MASSACHUSETTS, FOR THE FIFTH YEAR. THE COMPONENTS MEASURED INCLUDE INCOMING LONG-WAVE AND SHORT-WAVE SOLAR AND SKY RADIATION AND THE BALANCE OF INCOMING AND OUTGOING RADIATION OF ALL WAVE LENGTHS AT THE SURFACE OF THE GROUND. SIMILAR MEASUREMENTS WERE MADE FOR THE QUARTERMASTER CORPS BY SIGNAL CORPS TEAMS AT MAYNARD, MASSACHUSETTS; YUMA TEST STATION, ARIZONA; FORT HUACHUCA, ARIZONA; AND FORT CLAYTON, CANAL ZONE. MEASUREMENTS OF INCOMING SHORT-WAVE RADIATION RECEIVED ON A SOUTH-FACING SURFACE AT  $45^{\circ}$  ANGLE FROM THE HORIZONTAL WERE MADE AT MAYNARD IN SUPPORT OF TEXTILE EXPOSURE TESTS SIMILARLY ORIENTED.

MANY HARMFUL PHOTO-CHEMICAL CHANGES ARE ACTIVATED IN POLYMERIC AND TEXTILE MATERIALS BY ENERGY IN CERTAIN NARROW BANDS OF THE SOLAR SPECTRUM. SPECTRAL ENERGY MAY DAMAGE A SPECIFIC MATERIAL BY ACTING UPON IT DIRECTLY TO CAUSE ITS DETERIORATION OR BY ACTING UPON CERTAIN FINISHES, THE BREAK-DOWN PRODUCTS OF WHICH THEN CONTRIBUTE TO THE DETERIORATION OF THE MATERIAL. ALTHOUGH MUCH INFORMATION IS AVAILABLE ON THE EFFECT OF TOTAL SUNLIGHT ON MATERIALS, RADIATION SENSING EQUIPMENT USED IN THE PAST HAS NOT BEEN FINE ENOUGH TO PIN-POINT THE EXACT WAVELENGTHS RESPONSIBLE FOR DETERIORATION. THROUGH THE SUPPORT OF THE SIGNAL CORPS METEOROLOGY DEPARTMENT AND THE U.S. WEATHER BUREAU, EQUIPMENT CAPABLE OF MEASURING INCOMING SOLAR RADIATION IN SPECTRAL BANDS HAS BEEN INSTALLED ON THE SUMMIT OF MAUNA LOA IN HAWAII, AT AN ELEVATION OF 13,000 FEET ABOVE SEA LEVEL, AND AT SEA LEVEL AT THE BASE OF THE SAME MOUNTAIN. THIS EQUIPMENT WILL PROVIDE VALUABLE DATA IN SUPPORT OF STUDIES OF MATERIAL DETERIORATION, AND FOR STUDIES OF THE ABSORPTION OF SPECTRAL BAND RADIANT ENERGY BY THE ATMOSPHERE. SIMILAR EQUIPMENT WAS INSTALLED AT MAYNARD, MASSACHUSETTS, TO PROVIDE DIRECT SUPPORT FOR EXPOSURE TESTS OF QUARTERMASTER MATERIALS.

AN INVESTIGATION WAS STARTED OF INCOMING SHORT-WAVE SOLAR RADIATION AND ITS RELATION TO STANDARD WEATHER DATA. THIS INVESTIGATION, WHICH IN ITS INITIAL STAGES IS RESTRICTED TO THE ARID BASINS AND PLATEAUS OF THE WESTERN UNITED STATES, HAS AS ITS GOAL THE DEVELOPMENT OF A TECHNIQUE FOR PREDICTING SOLAR RADIATION IN PARTS OF THE WORLD WHERE RADIATION DATA ARE LACKING BUT STANDARD WEATHER OBSERVATIONS ARE AVAILABLE. PERCENT OF POSSIBLE SUNSHINE, CLOUD COVER, ATMOSPHERIC MOISTURE CONTENT, BAROMETRIC PRESSURE, AND NATURE OF THE GROUND COVER ARE THE ELEMENTS BEING INVESTIGATED. ELEVEN YEARS OF DAILY DATA FROM 10 STATIONS AND MONTHLY DATA FROM 35 STATIONS HAVE BEEN PLACED ON EAM CARDS AND ARE BEING SUBJECTED TO MULTIPLE CORRELATION ANALYSIS TO DETERMINE THE ROLE OF THE VARIABLES IN CONTROLLING SOLAR RADIATION.

A STUDY OF NATURAL DAYLIGHT ILLUMINATION AND ITS RELATION TO INCOMING SOLAR RADIATION WAS COMPLETED AND HAS BEEN SUBMITTED FOR PUBLICATION IN



THE OPEN LITERATURE. THE STUDY ESTABLISHED A HIGH CORRELATION AND CLOSE LINEAR RELATIONSHIP BETWEEN SOLAR RADIATION MEASURED BY AN EPPLEY PYRHELIOMETER AND ILLUMINATION (VISIBLE LIGHT) MEASURED BY A PHOTOCCELL (FIG. 11). THIS RELATIONSHIP WILL BE OF VALUE IN ESTABLISHING METHODS FOR PREDICTING THE ILLUMINATION CLIMATE OF THE COUNTRY FROM MORE READILY AVAILABLE SOLAR RADIATION DATA.

#### L. SUPPORT TO SCIENTIFIC EXPEDITIONS

DURING FY 61 TWO NEW EXPEDITIONS WERE SUPPORTED BY THE DEPARTMENT OF THE ARMY. THE MOUNT MCKINLEY RANGE EXPEDITION, LED BY MR. ADAMS CARTER, WAS GIVEN SUPPORT THROUGH LOAN OF SCIENTIFIC EQUIPMENT BY THE CORPS OF ENGINEERS. THIS EXPEDITION, WORKING ON THE NORTH FORK OF THE ELDRIDGE GLACIER, 20 MILES EAST OF MOUNT MCKINLEY, CARRIED OUT A GLACIOLOGICAL PROGRAM IN THE ACCUMULATION ZONES ABOVE AND NEAR THE FIRN LINE. AN EXPEDITION TO STUDY PATTERNED GROUND IN THE ANTARCTIC, SPONSORED BY THE UNIVERSITY OF WISCONSIN, WAS ALSO SUPPORTED BY THE LOAN OF SCIENTIFIC EQUIPMENT. THIS EXPEDITION WILL DETERMINE THE RATE OF GROWTH OF ICE WEDGES AND SAND WEDGES AND THE GEOLOGIC AND METEOROLOGIC FACTORS THAT INFLUENCE THEIR RATE OF GROWTH, AND WILL ATTEMPT TO DETERMINE WHICH GROW AND WHETHER EITHER MAY BE USED FOR DATING GEOMORPHIC EVENTS SUCH AS THE RETREAT OF GLACIAL FRONTS.

THE DEVON ISLAND EXPEDITION SPONSORED BY THE ARCTIC INSTITUTE OF NORTH AMERICA, REPORTED IN THE ANNUAL REPORT OF JUNE 1960, RETURNED TO THE FIELD TO BEGIN ACTIVE CONDUCT OF THE PLANNED SCIENTIFIC PROGRAM.

#### M. TROPIC ENVIRONMENTS

AN ANALYSIS OF ENVIRONMENTAL CONDITIONS AFFECTING TESTING IN THE PACIFIC SECTOR OF THE CANAL ZONE IS IN THE FINAL STAGE OF PREPARATION. THIS STUDY WAS BASED ON TWO FIELD SEASONS IN PANAMA IN COOPERATION WITH THE TRANSPORTATION CORPS. IN ADDITION TO A DETAILED ACCOUNT OF THE CLIMATE, TERRAIN, VEGETATION, AND TESTING FACILITIES AVAILABLE NEAR FORT KOBBE AND FORT CLAYTON, C. Z., THIS REPORT WILL GIVE SIMILAR INFORMATION FOR THE RIO HATO MILITARY RESERVATION IN PANAMA.

A CONTRACT WAS LET WITH INDIANA UNIVERSITY FOR STUDY OF THE CLIMATOLOGY OF SOUTHEAST ASIA, AND FIELD INVESTIGATIONS WERE INITIATED. THIS STUDY INCLUDES INVESTIGATION OF THE PRECIPITATION REGIME OF THAILAND, ENCOMPASSING A SUMMARY OF FREQUENCIES OF GIVEN INTENSITY LEVELS, DURATIONS AND SPACING OF RAINS, AND AREAL TYPES; CHANGE OF TEMPERATURE CONDITIONS WITH ELEVATION IN THE MOUNTAINOUS AREA OF BURMA; DIFFERENCES IN LAPSE RATES ON "DRY" AND "WET" SLOPES, AND SEASONAL VARIATIONS; FREQUENCY OF OCCURRENCE AND AREAL INCIDENCES OF TYPHOONS AND HIGH WINDS IN THE PHILIPPINE ISLANDS, AND THEIR DURATION AND RELATION TO "AVERAGE" WINDS; THE EFFECT OF HAZE, LOW CLOUDS, FOG, JUNGLE "STEAM," AND SMOKE ON VISIBILITY IN MALAYA; AND THE ALTITUDINAL ZONATION OF THESE PHENOMENA AND THE RELATION OF THEIR INCIDENCE TO DISTANCE FROM THE COAST.

A CONTRACT WITH THE UNIVERSITY OF MICHIGAN CALLS FOR AN INVESTIGATION OF THE COAST AND LANDING BEACH PHYSIOGRAPHY OF SOUTHEAST ASIA. THE

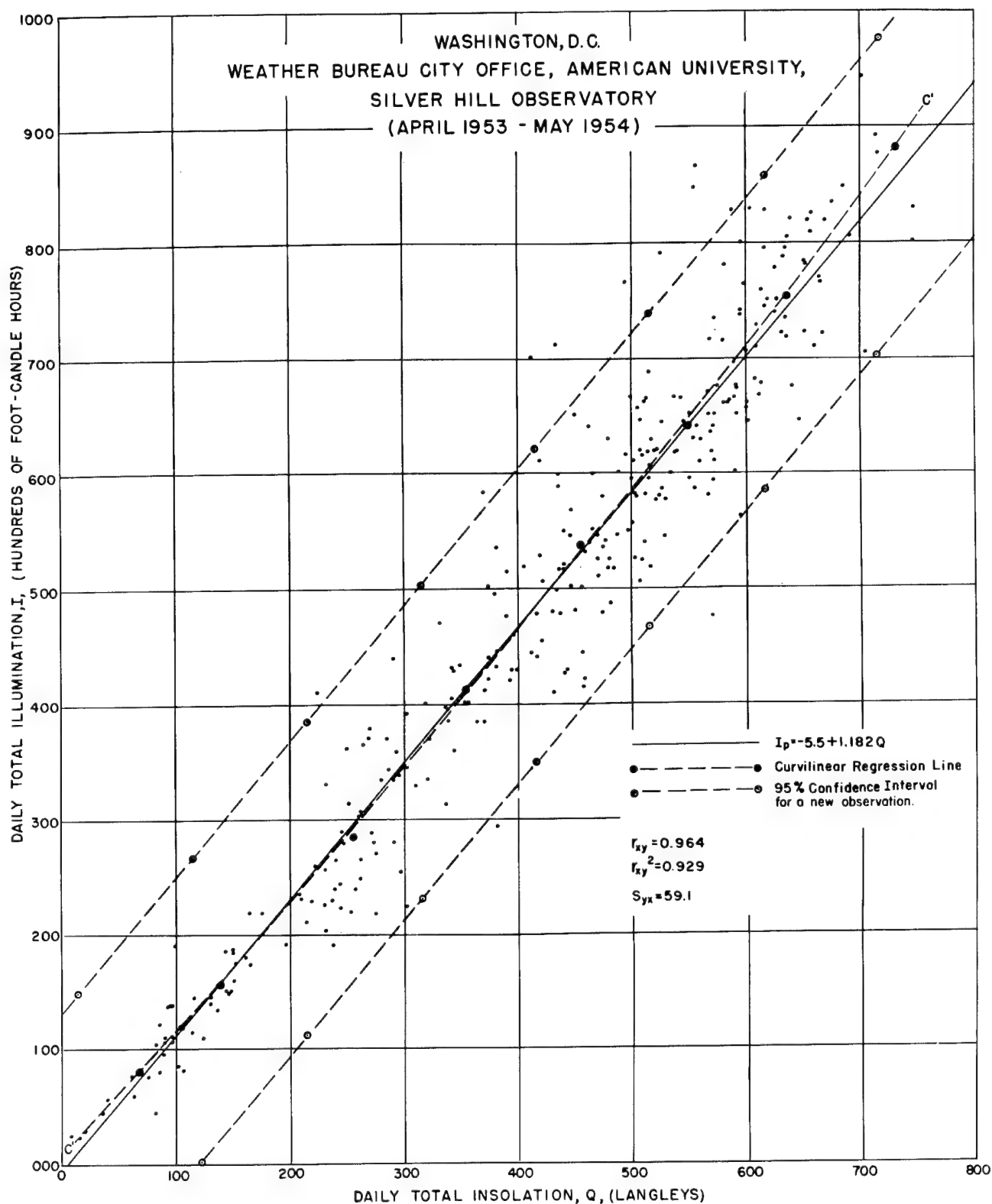


FIGURE 11: REGRESSION BETWEEN DAILY VALUES OF INCOMING SOLAR RADIATION ( $Q$ ) AND DAILY VALUES OF ILLUMINATION ( $I$ ) FOR OBSERVATIONS MADE AT THREE LOCATIONS IN WASHINGTON, D. C. THE DATA SHOW A HIGH CORRELATION AND CLOSE LINEAR RELATIONSHIP BETWEEN THE VARIABLES.

CONTRACTOR IS ENGAGED IN DETERMINING THE ENVIRONMENTAL ELEMENTS (E.G., LANDFORMS, SOILS, VEGETATION, NATIVE ANIMALS, DISEASES, AND THE PHYSICAL WORKS OF MAN) IN THE COASTAL AREAS OF SOUTHEAST ASIA WHICH SHOULD BE CONSIDERED IN THE DESIGN AND OPERATION OF ALL TYPES OF MILITARY EQUIPMENT.

INGREDIENTS OF THE NATURAL ENVIRONMENT ARE BEING STUDIED IN THEIR INTER-RELATIONSHIPS AND INTER-ACTIONS IN SUCH A MANNER AS TO PRODUCE A REGIONAL CLASSIFICATION OF THE COASTS AND LANDING BEACHES. A SIMILARITY OF MILITARY PROBLEMS IS TO BE THE OVER-RIDING CONCERN IN DIFFERENTIATING AMONG AND WEIGHING REGIONAL CHARACTERISTICS.

IT IS EXPECTED THAT, IN ADDITION TO PROVIDING USEFUL INFORMATION ON THE ENVIRONMENT OF SOUTHEAST ASIA, THIS RESEARCH WILL DEVELOP AN IMPROVED METHODOLOGY FOR MAKING ANALYSES OF NATURAL ENVIRONMENTS AND WILL INDICATE THE NATURE OF MOST OF THE COASTAL AND CLIMATIC TYPES COMMON TO TROPICAL AREAS.

## 7. SIGNAL CORPS

### A. METEOROLOGICAL SUPPORT TO ARMY RESEARCH AND DEVELOPMENT ACTIVITIES

DURING THIS PERIOD, THE SIGNAL CORPS PROVIDED METEOROLOGICAL TEAMS AT FIFTEEN SITES FROM ALASKA TO THE CANAL ZONE FOR OBSERVATION AND COLLECTION OF METEOROLOGICAL DATA IN SUPPORT OF R&D ACTIVITIES INCLUDING ENVIRONMENTAL RESEARCH PROGRAMS. SUPPORT TO THE QUARTERMASTER CORPS AT CANAL ZONE, GREENLAND, FT. HUACHUCA AND YUMA, ARIZONA, NATICK AND MAYNARD, MASSACHUSETTS, AND PUERTO RICO WAS PROVIDED DURING THIS PERIOD. IN ADDITION, METEOROLOGICAL SUPPORT WAS INITIATED BY CROSS-SERVICE ORDER TO THE WEATHER BUREAU IN HAWAII IN SUPPORT OF QUARTERMASTER CORPS RADIATION EFFECTS TESTS. OTHER SITES AT WHICH METEOROLOGICAL DATA WERE COLLECTED IN SUPPORT OF VARIOUS TECHNICAL SERVICES INCLUDED DUGWAY, UTAH; EDGEWOOD, MARYLAND; HOUGHTON, MICHIGAN; FORT MONMOUTH, NEW JERSEY; REDSTONE ARSENAL, ALABAMA; WHITE SANDS MISSILE RANGE, NEW MEXICO; FORT CHURCHILL, CANADA; AND FORT GREELY, ALASKA.

### B. METEOROLOGICAL RESEARCH

UNDER ITS ASSIGNMENT OF PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT IN THE FIELD OF METEOROLOGY (APPENDIX 1), THE SIGNAL CORPS IS CONDUCTING SEVERAL PROGRAMS, THE RESULTS OF WHICH WILL CONTRIBUTE SIGNIFICANTLY TO A BETTER UNDERSTANDING OF THE ENVIRONMENT AND TO THE ARMY'S FUTURE CAPABILITY FOR CONDUCTING ENVIRONMENTAL RESEARCH. PUBLICATIONS IN THIS FIELD ARE LISTED IN THE SIGNAL CORPS' ANNUAL REPORT ON ITS COGNIZANCE FOR ARMY METEOROLOGY. THESE PROGRAMS ARE BRIEFLY DESCRIBED BELOW:

#### (1) ARCTIC METEOROLOGICAL RESEARCH

THIS WORK INCLUDES BASIC RESEARCH REQUIRED TO UNDERSTAND THOSE METEOROLOGICAL PHENOMENA AND PROCESSES WHICH ARE PECULIAR TO ARCTIC AREAS. THESE INCLUDE SUCH PHENOMENA AS WHITEOUT, THE STABILITY OF THE ATMOSPHERE OVER ICE CAPS, THE LACK OF ATMOSPHERIC AEROSOLS, AND THE CONTRIBUTION OF THE ARCTIC AREAS TO THE EARTH'S ENERGY BALANCE. THE PROGRAM IS DESIGNED TO DEVELOP A KNOWLEDGE OF ARCTIC METEOROLOGY THAT WOULD BE USEFUL IN ARMY ARCTIC OPERATIONS.

#### (2) TROPICAL METEOROLOGICAL RESEARCH

THIS EFFORT IN BASIC RESEARCH IS DIRECTED TOWARD UNDERSTANDING THE METEOROLOGICAL PHENOMENA AND PROCESSES PECULIAR TO TROPICAL AREAS. THE OBJECTIVE IS TO DEVELOP NEW KNOWLEDGE OF TROPICAL METEOROLOGY FOR ARMY USE IN TROPICAL REGIONS. INCREASED EFFORT IN THIS AREA IS PLANNED TO ESTABLISH AND IDENTIFY DETAILS OF THE ENVIRONMENT FOR DIFFERENT TYPES OF TROPICAL REGIONS, I.E., RAINY TROPICS, WET-DRY TROPICS, MONSOON TROPICS, TROPICAL DESERTS, AND TROPICAL HIGHLANDS. THE WORK DURING THIS REPORTING PERIOD HAS BEEN CHIEFLY ON IDENTIFYING TROPICAL METEOROLOGICAL PROBLEMS AND THE FORMULATION OF A PLAN OF STUDY.

### (3) LOW LEVEL WIND RESEARCH

THIS WORK COVERS BASIC RESEARCH REQUIRED TO UNDERSTAND AND CORRECT FOR THE LOW LEVEL WINDS ON THE LAUNCHING OF FREE ROCKETS. THE RESULTS OF THE BASIC RESEARCH ON WIND VARIABILITY WITH TIME AND SPACE ARE APPLICABLE TO MANY VARIED ENVIRONMENTAL PROBLEMS. THE PROGRAM DURING THE REPORT PERIOD HAS BEEN ALONG THE LINES OF (1) RESEARCH IN THE PHYSICAL AND DYNAMIC PROCESSES INVOLVED IN THE BEHAVIOR OF LOW LEVEL WINDS, INCLUDING TERRAIN EFFECTS, VERTICAL FLOW, TURBULENCE, AND LOCAL CIRCULATION, (2) RE-EVALUATION OF KNOWN TECHNIQUES UNDER NEW CONDITIONS, (3) EXPLORATION OF NEW TECHNIQUES FOR OBTAINING INTEGRATED WIND EFFECTS, AND (4) INVESTIGATION OF THE USE OF ANALOGUE COMPUTER TECHNIQUES FOR SHORT-RANGE PREDICTION OF CHANGES IN THE LOW LEVEL WIND FIELD.

### (4) SMALL-SCALE METEOROLOGICAL RESEARCH

THIS EFFORT COVERS THE BASIC RESEARCH REQUIRED TO UNDERSTAND THE PHYSICAL PROCESSES OF LOCAL EXCHANGE OF ENERGY BETWEEN THE ATMOSPHERE AND THE EARTH'S SURFACE. THIS EXCHANGE OF ENERGY CAUSES LOCAL VARIATION OF METEOROLOGICAL PARAMETERS WHICH ARE IMPORTANT TO MANY ARMY OPERATIONS. THE VARIATIONS ARE CAUSED BY DIFFERING TERRAIN FEATURES, SOIL TYPES, AND VEGETATION AS WELL AS OTHER FACTORS. A BETTER UNDERSTANDING OF THESE LOCAL VARIATIONS WILL CONTRIBUTE DIRECTLY TO THE ENVIRONMENTAL RESEARCH PROGRAM. WORK DURING THIS PERIOD WAS PRIMARILY BY OUTSIDE CONTRACTS. INTERNAL EFFORTS INVOLVED THE EMPLOYMENT OF AN ANALOGUE COMPUTER TO STUDY THE INTER-RELATIONSHIP OF THE METEOROLOGICAL PARAMETERS INVOLVED.

### (5) INSTRUMENTATION DEVELOPMENT

MANY ENVIRONMENTAL FACTORS, CREATED OR INFLUENCED BY METEOROLOGICAL CONDITIONS, CANNOT BE SUCCESSFULLY STUDIED AT THE PRESENT TIME BECAUSE OF A LACK OF ADEQUATE INSTRUMENTATION TO MEASURE THE METEOROLOGICAL FACTORS. IN THE CASE OF SOME METEOROLOGICAL PARAMETERS SUCH AS SOIL TEMPERATURE, SOIL MOISTURE, DESERT HUMIDITIES, HIGH ALTITUDE PROBING, PARTICULATE MATTER IN THE ATMOSPHERE, ETC., PRESENT-DAY METEOROLOGICAL INSTRUMENTATION IS FAR FROM SATISFACTORY FROM THE STANDPOINT OF ACCURACY AND RELIABILITY. ALSO, AUTOMATION OF EXISTING METEOROLOGICAL MEASUREMENTS IS AN URGENT REQUIREMENT IN ORDER TO FACILITATE THE COLLECTION AND ANALYSIS OF METEOROLOGICAL DATA FOR ENVIRONMENTAL STUDIES. ACTIVITIES WERE CONTINUED IN THE DEVELOPMENT OF NEW EQUIPMENT AND IN IMPROVEMENT AND AUTOMATION OF EXISTING EQUIPMENT FOR MEASURING THOSE METEOROLOGICAL PARAMETERS USED TO DESCRIBE OR STUDY THE ENVIRONMENT.

### (6) THE ELECTRONIC ENVIRONMENTAL TEST FACILITY

DURING THIS REPORT PERIOD THE SIGNAL CORPS CONTINUED IMPLEMENTATION OF THE ELECTRONIC ENVIRONMENTAL TEST FACILITY IN SOUTHERN ARIZONA. WHILE THIS FACILITY WILL BE USED PRIMARILY TO MEASURE AND STUDY THE ELECTRO-

MAGNETIC ENVIRONMENT IN WHICH THE ARMY OPERATES, THE TERRAIN AND METEOROLOGICAL STUDIES NECESSARY TO SUPPORT THE STUDIES OF THE ELECTRO-MAGNETIC ENVIRONMENT WILL, AS A BY-PRODUCT, CONTRIBUTE TO THE ARMY'S ENVIRONMENTAL RESEARCH PROGRAM.

## 8. TRANSPORTATION CORPS

THAT PORTION OF THE TRANSPORTATION CORPS PROGRAM CLOSELY RELATED TO ENVIRONMENTAL RESEARCH WAS CONDUCTED BY THE U.S. ARMY TRANSPORTATION ENVIRONMENTAL OPERATIONS GROUP (TREG) WHOSE MISSION IS TO "PROVIDE TRANSPORTATION SUPPORT FOR MILITARY ACTIVITIES IN DIFFICULT ENVIRONMENTS, AND TO CONDUCT OPERATIONS LEADING TO IMPROVEMENT OF DIFFICULT ENVIRONMENT CAPABILITIES." ACCOMPLISHMENTS IN THE NATURAL DIFFICULT ENVIRONMENTS ARE AS FOLLOWS:

### A. ARCTIC OPERATIONS

PROJECT POLE HOP WAS AN AVIATION EXERCISE WITH THE MISSION OF CONDUCTING AERIAL OPERATIONS IN THE POLAR BASIN NORTH OF STATION ALERT, ELLESMERE ISLAND, NORTHWEST TERRITORIES, CANADA, IN ORDER TO STUDY INDEPENDENT AVIATION LOGISTICS AND OPERATIONAL CAPABILITIES IN EXTREME NORTHERN REGIONS (39). THE AIRCRAFT, TWO U1-A OTTERS, IN SKI CONFIGURATION, REQUIRED LIMITED MAINTENANCE AND WERE WELL ADAPTED FOR USE IN THE POLAR BASIN. THE DOPPLER NAVIGATION SYSTEM DISPLAYED ACCURACY WITHIN SPECIFICATIONS OVER ALL TYPES OF ARCTIC TERRAIN COVERED BY THE PROJECT FLIGHTS. THESE INCLUDED: THE GREENLAND ICECAP, THE MOUNTAINS OF THE UNITED STATES RANGE, AND THE SEA ICE OF THE POLAR BASIN. A TOTAL OF APPROXIMATELY 6,000 NAUTICAL MILES WAS FLOWN DURING THE PROJECT.

PROJECT LEAD DOG 60 WAS A COMBINED SURFACE AND AIR EXPLORATION EXPEDITION IN NORTHERN GREENLAND CONDUCTED BY THE TRANSPORTATION CORPS (FIG. 12). THE SURFACE PARTY TRAVELED OVER 1700 MILES WHILE OPERATING OVER THE ICECAP AND IN THE ICE-FREE LAND AREAS OF NORTHEAST GREENLAND. THE AIR ELEMENT, COMPOSED OF TWO H34C HELICOPTERS, TRAVELED 8000 MILES WHILE TRANSPORTING SCIENTISTS TO MANY INACCESSIBLE AREAS OF PEARY LAND AND PRINCE CHRISTIAN LAND. IN ADDITION TO SUPPORTING SCIENTIFIC STUDIES, THE PROJECT SUCCESSFULLY COMPLETED ITS MISSION OF MARKING A TRAIL TO THE EASTERN EDGE OF THE ICECAP AND LOCATING DESCENT ROUTES FROM THE ICECAP TO THE ICE-FREE LAND AREAS OF WALCOTT'S LAND AND CROWN PRINCE CHRISTIAN LAND. SCIENTISTS AND MILITARY TECHNICIANS FROM 10 MILITARY AND CIVILIAN RESEARCH INSTITUTES PARTICIPATED IN THE PROJECT TO COLLECT SCIENTIFIC DATA. PERSONNEL REPRESENTING THE FOLLOWING AGENCIES PARTICIPATED: GEOLOGICAL SURVEY, QUARTERMASTER CORPS RESEARCH AND ENGINEERING COMMAND, THE U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, TRANSPORTATION CORPS RESEARCH COMMAND, ARMY MAP SERVICE, U.S.A.F. CAMBRIDGE RESEARCH LABORATORIES, CHEMICAL CORPS ENVIRONMENTAL TEST DIVISION, SIGNAL CORPS RESEARCH AND DEVELOPMENT CENTER, THE TRANSPORTATION ENVIRONMENTAL OPERATIONS GROUP, AND THE U.S. NAVY AIR DEVELOPMENT SQUADRON SIX.

PROJECT TOP DOG 60 WAS A LIGHT VEHICLE RECONNAISSANCE OVER THE SEA ICE IN THE SOUNDS BETWEEN GREENLAND AND CANADA. A 5-MAN, 3-WEASEL PARTY TRAVELED A TOTAL OF 220 MILES OVER THE ICE NORTH OF THULE AIR BASE WHILE TRYING TO FIND A ROUTE AROUND THE OPEN WATER AND WEAK ICE SURROUNDING KAP PARRY. THIS PROJECT HAD THE MISSION OF DETERMINING THE FEASIBILITY

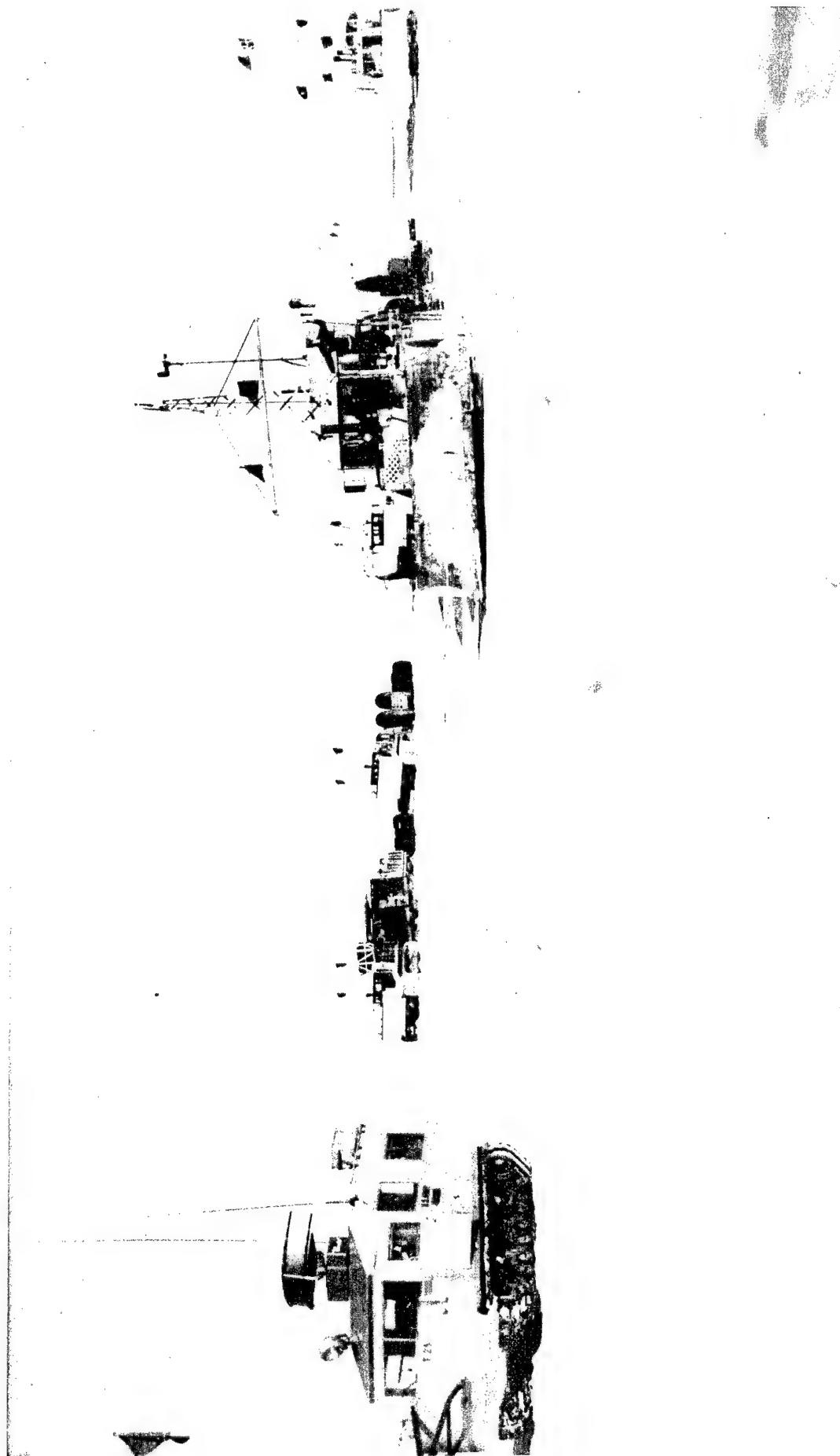


FIGURE 12: PROJECT "LEAD DOG" CROSSING THE GREENLAND ICE CAP. VEHICLES SHOWN INCLUDE A MODIFIED WEASEL WITH RADAR FOR USE DURING WHITEOUTS, AND TRACTORS PULLING SLED, 1,000 GALLON ROLLING LIQUID TRANSPORTER, AND WANAGONS.



OF UTILIZING SEA ICE AS A TRANSPORTATION MEDIUM. ONE HYDROGRAPHER FROM THE U.S. NAVY HYDROGRAPHIC OFFICE ACCOMPANIED THE PARTY.

#### B. ANTARCTIC OPERATIONS

A REPRESENTATIVE OF TREGO ACCOMPANIED THE NAVY TASK FORCE AS THE NAVIGATOR ON THE TRAVERSE FROM BYRD STATION TO THE SOUTH POLE. THE MISSION OF THIS PROJECT WAS TO ESTABLISH AND MARK A SAFE TRAIL TO THE POLE AND TO LOCATE GEOGRAPHICALLY, BY CELESTIAL OBSERVATION AND TRIANGULATION, THE EAST END OF THE HOLICK MOUNTAINS AND TO DELIVER HEAVY EQUIPMENT REQUIRED FOR FUTURE CONSTRUCTION.

#### C. SUBARCTIC OPERATIONS

A REPRESENTATIVE OF TREGO SPENT SOME 60 DAYS IN THE MUSKEG AREAS OF CANADA OBSERVING CANADIAN OIL INDUSTRIES' APPROACH TO OPERATIONS IN THIS DIFFICULT ENVIRONMENT. CONSIDERABLE TIME AND EFFORT WERE SPENT IN THE INTERPRETATION OF PHOTOS AS A MEANS OF DETERMINING THE VARIOUS TYPES OF SOIL AND THEIR TRAFFICABILITY. THE NODWELL TRANSPORTER WAS OBSERVED TRAVERSING THESE MUSKEG AND TUNDRA REGIONS, BEARING HEAVY LOADS WITH LITTLE OR NO DIFFICULTY. AS A RESULT, IT WAS RECOMMENDED THAT THE TRANSPORTATION CORPS CONDUCT AN EVALUATION OF THIS TRANSPORTER IN A SUBSEQUENT OPERATION.

#### D. DESERT OPERATIONS

PROJECT DESERT CONVOY, CONDUCTED AT THE YUMA TEST STATION, ARIZONA, HAD THE MISSION OF CONDUCTING MILITARY MOTOR TRANSPORT OPERATIONS CROSS-COUNTRY IN ORDER TO DEVELOP TECHNIQUES FOR CONDUCTING SIMILAR OPERATIONS IN THE DESERTS OF AFRICA AND ASIA. IN ADDITION, A COMPARISON WAS MADE OF THREE STANDARD AND NON-STANDARD DESERT TIRE/WHEEL CONFIGURATIONS TO DETERMINE WHICH PROVIDES THE BEST TRACTION WHEN OPERATING OVER NON-COMPACTED SAND. THE TERRAIN OVER WHICH THE 12-MAN TEAM OPERATED WAS REPRESENTATIVE OF THAT EXISTENT TO VARYING DEGREES IN ALL THE DESERTS OF THE WORLD.

#### E. TROPICAL OPERATIONS

PROJECT TROPICAL WET TOOK PLACE DURING NOVEMBER AND DECEMBER 1960 IN THE PANAMA CANAL ZONE AND THE REPUBLIC OF PANAMA. MEN, VEHICLES, AND AIRCRAFT OPERATED FROM THE TRACKLESS JUNGLE 70 MILES EAST OF THE CANAL ZONE TO THE RUGGED MOUNTAINS ALONG THE COSTA RICAN BORDER, 33 MILES NORTHWEST OF THE CANAL ZONE. EQUIPMENT CONSISTED OF VARIOUS TACTICAL VEHICLES, M29C WEASEL CARGO CARRIERS, ROLLING LIQUID TRANSPORTERS, H-34 HELICOPTERS, AND THE JUNGLE-TRAC TRACTION DEVICE.

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APPENDIX 1

DEPARTMENT OF THE ARMY  
GENERAL STAFF, UNITED STATES ARMY  
WASHINGTON 25, D.C.

CSGLD/F1 28507

10 JUNE 1949

MEMORANDUM FOR: CHIEF OF ORDNANCE  
CHIEF OF ENGINEERS  
CHIEF OF TRANSPORTATION  
CHIEF, CHEMICAL CORPS  
CHIEF SIGNAL OFFICER  
THE QUARTERMASTER GENERAL  
THE SURGEON GENERAL  
CHIEF, ARMY SECURITY AGENCY  
CHIEF, ARMY FIELD FORCES

SUBJECT: ASSIGNMENT OF RESEARCH AND DEVELOPMENT COGNIZANCE IN THE FIELDS  
OF CRYOLOGICAL PHENOMENA, METEOROLOGY, AND ENVIRONMENTAL RESEARCH

1. REFERENCES:

A. MEMORANDUM, THIS OFFICE, SUBJECT: "DEFINITION OF PRIMARY  
COGNIZANCE AS APPLIED TO RESEARCH AND DEVELOPMENT ACTIVITIES," DATED 24  
NOVEMBER 1948.

B. RDB 165/2.1 (WITH ATTACHMENTS) WHEREIN THE RDB ASSIGNED  
PRIMARY RESPONSIBILITY FOR RESEARCH AND DEVELOPMENT IN THE FIELD OF SNOW,  
ICE AND PERMAFROST ON AND BENEATH THE LAND SURFACE (EXCEPT THE LITTORAL)  
TO THE DEPARTMENT OF THE ARMY.

C. RDB 133/2, "STATEMENT OF POLICY AND ALLOCATION OF RESPON-  
SIBILITY FOR RESEARCH AND DEVELOPMENT PROGRAMS," AS SUPPLEMENTED BY  
RDB 133/3 AND RDB 133/4.

2. A. PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT IN THE FIELD  
OF CRYOLOGICAL PHENOMENA PERTAINING TO SNOW, ICE AND PERMAFROST ON AND BE-  
NEATH THE EARTH'S SURFACE IS ASSIGNED TO THE CHIEF OF ENGINEERS. THIS  
ASSIGNMENT INCLUDES RESPONSIBILITY WITHIN THE NATIONAL MILITARY ESTABLISH-  
MENT FOR RESEARCH AND DEVELOPMENT PERTAINING TO CRYOLOGICAL PHENOMENA  
ON AND BENEATH THE LAND SURFACE (EXCEPT THE LITTORAL) AS ASSIGNED TO THE  
DEPARTMENT OF THE ARMY BY THE RESEARCH AND DEVELOPMENT BOARD IN REFERENCE  
1 B ABOVE.

B. IN ADDITION TO THE RESPONSIBILITIES OUTLINED IN REFERENCE  
1 A ABOVE, THE ADDITIONAL RESPONSIBILITIES OF THE DEPARTMENT OF THE ARMY AS

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SUBJECT: ASSIGNMENT OF RESEARCH AND DEVELOPMENT COGNIZANCE IN THE FIELDS OF CRYOLOGICAL PHENOMENA, METEOROLOGY, AND ENVIRONMENTAL RESEARCH

SET FORTH IN PARAGRAPH 5 OF REFERENCE 1 C ABOVE ARE DELEGATED TO THE CHIEF OF ENGINEERS. THE CHIEF OF ENGINEERS WILL INSURE THAT ALL QUESTIONS OF INDIVIDUAL DEPARTMENTAL RESPONSIBILITY ARE EITHER SETTLED BY MUTUAL AGREEMENT, OR IN THE EVENT OF DISAGREEMENT, ARE SUBMITTED TO THE DEPUTY DIRECTOR FOR RESEARCH AND DEVELOPMENT FOR DECISION. DISAGREEMENTS TO SUCH DECISIONS WILL BE REFERRED BY THE PROPOSING DEPARTMENT TO THE RESEARCH AND DEVELOPMENT BOARD FOR RESOLUTION.

C. THE CHIEF OF ENGINEERS IS CHARGED WITH KEEPING THE DEPARTMENTS OF NAVY AND AIR FORCE FULLY ADVISED OF THE CURRENT STATUS AND PROGRESS IN THIS FIELD AND WILL MAINTAIN DIRECT LIAISON FOR THAT PURPOSE.

3. A. PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT WITHIN THE RESPONSIBILITIES OF THE DEPARTMENT OF THE ARMY IN THE FIELD OF METEOROLOGY IS ASSIGNED TO THE CHIEF SIGNAL OFFICER. METEOROLOGY IS DEFINED AS THE SCIENCE OR THAT BRANCH OF PHYSICS WHICH TREATS OF THE PHYSICAL, CHEMICAL, AND ELECTRICAL PARAMETERS OF THE ENTIRE GASEOUS ENVELOPE OF THE EARTH, SUCH AS COMPOSITION, WIND, PRESSURE, TEMPERATURE, HUMIDITY, AND THE VARIOUS PHENOMENA ASSOCIATED THEREWITH, INCLUDING ALL THEORETICAL, SYNOPTIC AND INSTRUMENTAL ASPECTS OF THE SAME. THIS ASSIGNMENT DOES NOT INCLUDE THE APPLICATION OF METEOROLOGICAL DATA TO NON-METEOROLOGICAL TECHNIQUES, SUCH AS SOUND-RANGING, ELECTRO-MAGNETIC WAVE PROPAGATION, AND SPECIALIZED ENVIRONMENTAL STUDIES EXCEPT WHEN SUCH TECHNIQUES ARE USED AS METEOROLOGICAL TOOLS.

B. NO ASSIGNMENT OF RESEARCH AND DEVELOPMENT RESPONSIBILITY FOR THE SUBJECT FIELD HAS BEEN MADE BY THE RESEARCH AND DEVELOPMENT BOARD.

4. A. PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT WITHIN THE RESPONSIBILITIES OF THE DEPARTMENT OF THE ARMY IN THE FIELD OF APPLIED ENVIRONMENTAL RESEARCH IS ASSIGNED TO THE QUARTERMASTER GENERAL. APPLIED ENVIRONMENTAL RESEARCH IS DEFINED AS THE COLLATION OF STATISTICAL, METEOROLOGICAL, CLIMATIC, AND GEOGRAPHICAL DATA AS ACCUMULATED BY THE RESPONSIBLE AGENCIES, THE INTERPRETATION OF THESE DATA, AND THE PRESENTATION OF THE EVALUATED INFORMATION IN SUITABLE FORM FOR APPLICATION BY APPROPRIATE AGENCIES TO LOGISTICS PROBLEMS OF EQUIPMENT, PERSONNEL, AND OPERATIONAL FUNCTIONS. THIS ASSIGNMENT EXCLUDES THE FIELD OF SNOW, ICE AND PERMA-FROST AS COVERED BY PARAGRAPH 2 A ABOVE.

B. NO ASSIGNMENT OF RESEARCH AND DEVELOPMENT RESPONSIBILITY FOR THE SUBJECT FIELD HAS BEEN MADE BY THE RESEARCH AND DEVELOPMENT BOARD.



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SUBJECT: ASSIGNMENT OF RESEARCH AND DEVELOPMENT COGNIZANCE IN THE FIELDS  
OF CRYOLOGICAL PHENOMENA, METEOROLOGY, AND ENVIRONMENTAL RESEARCH

5. THE WAR DEPARTMENT RESEARCH AND DEVELOPMENT PROGRAM FOR FISCAL  
YEAR 1949 THE DEPARTMENT OF THE ARMY RESEARCH AND DEVELOPMENT PROGRAM  
FOR FISCAL YEAR 1950, AND THE DEPARTMENT OF THE ARMY RESEARCH AND DEVEL-  
OPMENT PLAN FOR FISCAL YEAR 1951 ARE AMENDED ACCORDINGLY.

BY ORDER OF THE UNDER SECRETARY OF THE ARMY:

C. G. HELMICK  
MAJOR GENERAL, GSC  
DEPUTY DIRECTOR FOR  
RESEARCH AND DEVELOPMENT  
LOGISTICS DIVISION

APPENDIX 2

FILE NO.

G4/F2

41949

SUBJECT: TRANSFER OF SIX ARMY-WIDE  
ENVIRONMENTAL RESEARCH PROJECTS  
TO THE QUARTERMASTER GENERAL

TO THE QUARTERMASTER GENERAL FROM G4 DATE 30 JUNE 1952 COMMENT NO.1  
ATTN: MILITARY PLANNING DIVISION DR. PAUL A. SIPLE/53665/KJW  
RESEARCH AND DEVELOPMENT BRANCH

1. AN EVALUATION OF THE ENVIRONMENTAL RESEARCH PROGRAMS OF THE ARMY REVEALS THAT SEVERAL REQUIREMENTS EXIST WITHIN FIELDS OF COGNIZANCE ASSIGNED TO YOU WHICH ARE NOT CURRENTLY INCLUDED IN ANY PROGRAM. THEY ARE:

A. RESEARCH ON TECHNIQUES OF APPLICATION OF ENVIRONMENTAL KNOWLEDGE TO ARMY-WIDE MILITARY PROBLEMS.

B. SUPPORT OF ENVIRONMENTAL AND GEOGRAPHIC RESEARCH ON GEOGRAPHIC EXPEDITIONS AND OTHER FIELD PROJECTS NOT SPECIFICALLY ORGANIZED BY AGENCIES OF D/A. THE INTERESTS OF ALL D/A AGENCIES ARE INCLUDED IN THIS PROJECT. THIS FINANCIAL SUPPORT DOES NOT CONFLICT WITH EXISTING POLICIES FOR EXPEDITION SUPPORT BUT IS SUPPLEMENTARY TO THEM.

C. ESTABLISHMENT OF RAPID SYSTEM FOR THE ANALYSIS OF PERFORMANCE OF ARMY EQUIPMENT UNDER ALL ENVIRONMENTAL CONDITIONS FOLLOWING THE PRINCIPLES OF RECOMMENDED IN ORO-R-4, DATED 12 JULY 1950, (PROJECT ENVANAL).

D. DEVELOPMENT OF A SYSTEM WHEREBY MILITARY AREAS CAN BE ANALYZED IN TERMS OF ENVIRONMENTAL STRESSES, AND RESULTS ORGANIZED IN A FORM ADAPTABLE TO MACHINE TABULATION. THIS WILL BE THE BASIC INFORMATION AGAINST WHICH THE PERFORMANCE OF ARMY EQUIPMENT WILL BE EVALUATED BY THE RAPID SYSTEM IN C ABOVE, PERMITTING A REGIONAL EVALUATION OF THE CAPABILITIES OF MILITARY EQUIPMENT IN THE FORM OF LOGISTICS AND OPERATIONS ALMANACS.

E. PREPARE RECOMMENDED D/A POLICIES ESTABLISHING DESIGN CRITERIA FOR PERFORMANCE OF ARMY EQUIPMENT AND MATERIEL UNDER ADVERSE CONDITIONS OF ENVIRONMENT SIMILAR TO SR 705-70-5.

F. RESEARCH ON RADICAL METHODS OF IMPROVEMENT IN PROTECTION OF PERSONNEL FROM ENVIRONMENTAL STRESSES. THIS PROJECT IS INTENDED TO SUPPORT NEW SCIENTIFIC CONCEPTS WHICH IF SUCCESSFUL, MAY BE IMPORTANT, BUT PRACTICABILITY OF APPLICATION CANNOT BE ASSURED FROM PRESENT KNOWLEDGE OF THE SUBJECT.

2. THE RESPONSIBILITY FOR CONDUCTING RESEARCH ON THESE PROBLEMS IS HEREBY ASSIGNED TO THE QUARTERMASTER GENERAL.

3. FUNDS IN THE AMOUNT OF \$479,000 HAVE BEEN INCLUDED IN THE FY 1953 ARMY-WIDE RESEARCH BUDGET TO COVER THESE PROJECTS. A SIMILAR AMOUNT IS

G4/F2

SUBJECT: TRANSFER OF SIX ARMY-WIDE ENVIRONMENTAL RESEARCH PROJECTS  
TO THE QUARTERMASTER GENERAL

INCLUDED IN THE FY 1954 ARMY-WIDE RESEARCH BUDGET FOR CONTINUANCE OF THESE PROJECTS. SUBSEQUENT FUNDING ACTIONS ON BUDGETS BEYOND FY 1954, ARE THE RESPONSIBILITY OF YOUR OFFICE. UPON AVAILABILITY, FUNDS REFERRED TO WILL BE TRANSFERRED TO THE QUARTERMASTER GENERAL. THE ASSIGNMENT OF TECHNICAL OBJECTIVES AND DIVISION OF FUNDS IS AS FOLLOWS:

<u>PROJECT NO.</u>	<u>TITLE</u>	<u>TECHNICAL OBJECTIVE</u>	<u>BUDGET PROJECT</u>	<u>FUNDED IN FY 1953</u>
*A. OX8305001Z	RESEARCH ON APPLICATIONS OF ENVIRONMENTAL TECHNIQUES	10-16	1520	\$50,000
B. OX8303002Z	SUPPORT OF ENVIRONMENTAL AND GEOGRAPHIC RESEARCH ON GEOGRAPHIC EXPEDITIONS AND OTHER FIELD PROJECTS NOT SPECIFICALLY ORGANIZED BY AGENCIES OF D/A.	10-16	1520	\$100,000
C. OX8305002Z	ESTABLISHMENT OF MACHINE TABULATION SYSTEM OF RECORDING EQUIPMENT PERFORMANCE UNDER SPECIFIC CONDITIONS OF THE ENVIRON- MENT (ENVANAL)	10-16	1520	\$150,000
D. OX8303001Z	DEVELOPMENT OF TECHNIQUES AND ESTABLISHMENT OF GEOGRAPHIC BASE FOR "LOGISTICS AND OPERATIONS ALMANACS".	10-16	1520	\$100,000
E. OX8301001Z	RESEARCH FOR ESTABLISHMENT OF ARMY-WIDE ENVIRONMENTAL DESIGN CRITERIA STANDARDS	10-16	1520	\$29,000
F. OX8301005Z	RESEARCH ON AND DEVELOPMENT OF RADICAL IMPROVEMENTS IN ENVIRONMENTAL PROTECTION OF PERSONNEL	10-16	1520	\$50,000

\*THIS IS A CONTINUATION OF FY 1952 PROJECT PREVIOUSLY TRANSFERRED TO YOUR OFFICE.

4. DUE TO THE ARMY-WIDE INTEREST IN THESE PROJECTS, MONITORSHIP WILL BE MAINTAINED BY GENERAL STAFF. THE PRIMARY CONTACT FOR GENERAL STAFF IS DR. PAUL A. SIPLE, OACoFS, G-4, RESEARCH AND DEVELOPMENT DIVISION, RESEARCH

G4/F2

SUBJECT: TRANSFER OF SIX ARMY-WIDE ENVIRONMENTAL RESEARCH PROJECTS  
TO THE QUARTERMASTER GENERAL

BRANCH, (CHAIRMAN, DEPARTMENT OF THE ARMY COMMITTEE ON ENVIRONMENTAL  
FACTORS AND CONTROL). COORDINATION WITH INTERESTED AGENCIES WILL BE MAIN-  
TAINED BY THE PROJECT OFFICER, OQMG.

5. BACKGROUND DATA PERTAINING TO THESE PROJECTS IS LOCATED IN DR.  
SIPLE'S OFFICE, ROOM 3B-480, THE PENTAGON, AND ARE AVAILABLE TO YOUR  
PERSONNEL FOR INSPECTION AND TRANSFER, IF DESIRED.

6. IT IS REQUESTED THAT STEPS BE TAKEN AT THIS TIME TO INITIATE  
FORMAL PROJECTS FOR INCLUSION IN YOUR RESEARCH AND DEVELOPMENT PROGRAM.

/s/ MICHAEL BUCKLEY, JR.  
COLONEL, GS  
ASST. DEP. ACOFS, G-4, FOR  
RESEARCH & DEVELOPMENT

## APPENDIX 3

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT  
WASHINGTON 25, D. C.

CRD/M 7384  
R&D DIRECTIVE  
NUMBER 21

24 MAY 1960

THE APPLIED ENVIRONMENTAL RESEARCH PROGRAM  
OF THE DEPARTMENT OF THE ARMY - ANNUAL REPORT  
(REPORTS CONTROL SYMBOL CSCRD-23)

(EFFECTIVE UNTIL 23 MAY 1961 UNLESS SOONER RESCINDED OR SUPERSEDED.)

1. GENERAL:

A. THIS DIRECTIVE ESTABLISHES AND PROVIDES INSTRUCTIONS FOR PREPARATION OF THE DEPARTMENT OF THE ARMY ANNUAL REPORT ON APPLIED ENVIRONMENTAL RESEARCH. THIS REPORT IS FOR THE USE OF THE ARMY GENERAL STAFF AND ITS RESEARCH AND DEVELOPMENT AGENCIES, AND THE ARMY TECHNICAL SERVICES. IT IS ALSO USED BY THE ARMY COMMITTEE ON ENVIRONMENT AND THE ENVIRONMENTAL RESEARCH SUBPANEL, ARMY SCIENTIFIC ADVISORY PANEL. THE REPORT PROVIDES TECHNICAL AND PLANNING INFORMATION REQUIRED FOR THE SUPERVISION, COORDINATION, AND LONG RANGE PROGRAMMING OF ARMY EFFORTS IN APPLIED ENVIRONMENTAL RESEARCH. IT ALSO SUMMARIZES ARMY ACCOMPLISHMENTS IN THE FIELD OF APPLIED ENVIRONMENTAL RESEARCH.

B. IT IS ESSENTIAL THAT THE REPORT BE PREPARED ACCURATELY AND SUBMITTED ON A TIMELY BASIS SINCE IT IS USED AT ALL ECHELONS BY AGENCIES HAVING AN INTEREST IN APPLIED ENVIRONMENTAL RESEARCH FOR PURPOSES OF PROGRAM REVIEW, ANALYSIS, AND COORDINATION.

2. RESPONSIBILITIES:

A. THE QUARTERMASTER GENERAL HAS PRIMARY COGNIZANCE FOR RESEARCH AND DEVELOPMENT WITHIN THE RESPONSIBILITIES OF THE DEPARTMENT OF THE ARMY IN THE FIELD OF APPLIED ENVIRONMENTAL RESEARCH. HE WILL COMPILE THE ANNUAL REPORT, UTILIZING HIS OWN MATERIAL TOGETHER WITH MATERIAL CONTAINED IN FEEDER REPORTS SUPPLIED BY THE OTHER TECHNICAL SERVICES. THE ANNUAL REPORT WILL BE PREPARED AS OF THE END OF THE FISCAL YEAR.

B. CHIEFS OF THE TECHNICAL SERVICES WILL PREPARE CONTRIBUTIONS TO THE ANNUAL REPORT DESCRIBING THEIR RESPECTIVE PROGRAMS. THESE FEEDER REPORTS ARE TO BE SUBMITTED TO THE QUARTERMASTER GENERAL EACH YEAR AT A DATE SET BY THE QUARTERMASTER GENERAL. FEEDER REPORTS BEAR THE SAME CONTROL SYMBOL, CSCRD-23, AS THE ANNUAL REPORT.

CRD/M 7384

R&D DIRECTIVE NUMBER 21

SUBJECT: THE APPLIED ENVIRONMENTAL RESEARCH PROGRAM OF THE DEPARTMENT  
OF THE ARMY - ANNUAL REPORT (REPORTS CONTROL SYMBOL CSCRD-23)

C. INFORMATION INCLUDED IN THE ANNUAL REPORT MAY BE REFERRED TO,  
BUT NEED NOT BE INCLUDED, IN THE CONSOLIDATED R&D ANNUAL PROJECT REPORT,  
REPORTS CONTROL SYMBOL CSCRD-16.

D. THE ANNUAL REPORT WILL BE PREPARED IN ACCORDANCE WITH INCLO-  
SURE 1. EACH TECHNICAL SERVICE WILL CONTRIBUTE SPECIFICALLY TO THOSE  
SECTIONS DEALING WITH ITS ACCOMPLISHMENTS IN THIS FIELD AS WELL AS TO  
APPROPRIATE SECTIONS OF A GENERAL NATURE REFLECTING OVER-ALL ARMY ACCOM-  
PLISHMENTS IN APPLIED ENVIRONMENTAL RESEARCH.

BY DIRECTION OF THE CHIEF OF RESEARCH AND DEVELOPMENT:

1 INCL  
INSTRUCTIONS

ROLAND P. CARLSON  
COLONEL, GS  
EXECUTIVE

DISTRIBUTION:  
STANDARD

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